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# GURLEY'S HANDBOOK OF WEIGHTS AND MEASURES FOR THE USE OF SEALERS



FOURTH EDITION

W. & L. E. GURLEY  
TROY, NEW YORK, U. S. A.  
DEPARTMENT  
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**Sealers' Portable Equipment**

# A HANDBOOK

## FOR THE USE OF SEALERS OF WEIGHTS AND MEASURES

*Fourth Edition*

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PRICE, 50 CENTS

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W. & L. E. GURLEY  
TROY, N. Y., U. S. A.  
1912

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## INFORMATION TO PURCHASERS

**Ordering.** Orders should be written legibly and explicitly, specifying catalogue number. If the charges are to be made to a special board, regular order forms, signed by the proper authorities, should be used. The name and address should be written with particular care.

**Warranty.** Every instrument is carefully inspected and tested before leaving our factory. Safe delivery is guaranteed and any damage or defect will be rectified on prompt notification.

**Remittances.** Remittances should be made by bank drafts, post-office, or express money orders, payable to the order of W. & L. E. GURLEY, TROY, N. Y.

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## PREFACE

We present herewith the fourth edition of the Sealers Handbook, which supersedes all previous editions, in the hope that it will prove of benefit to those interested in the accurate inspecting and testing of weights and measures.

All unnecessary details have been omitted and explanations made as clearly and simply as possible in order that this book may stimulate the effort to have all weighing and measuring devices properly inspected and tested.

During the past few years public attention has been directed to the importance of securing full and just quantity as well as quality of all goods purchased and through the earnest efforts of the National Bureau of Standards and the members of the National Conference on Weights and Measures, legislation has been introduced in furtherance of this end.

At the present time more than one half of the States in the Union have enacted legislation providing for the inspection of scales, weights and measures, and regulating the sale of commodities. It is probable that in a few years a system will be in force throughout the United States which will compare favorably with that in foreign countries. It is impossible to estimate the amount of loss sustained by the purchasing public through the absence of this legislation in the past, but it is safe to say that a thorough system of regulation and inspection will do more than anything else to reduce the present high cost of living.

Since we began the manufacture of Precision Weights and Measures in 1904, we have spared nothing to secure the accuracy and workmanship which has become characteristic of our other manufactures.

Although peculiarly fitted for this work on account of our extensive equipment and corps of expert workmen familiar with the manufacture of instruments of precision,

we find many problems confronting us and these are most carefully studied in the endeavor to attain best results.

The aging of material, the elimination of internal defects, the selection of the best forms of apparatus and the exact testing of all products, present problems, solved only by constant study and experiment.

Our weights and measures are guaranteed to conform to the specifications as established by the National Bureau of Standards, Washington, D. C.

Capacity measures are made of a special hard rolled brass or aluminum; the inside walls are smooth and have no projections or seams to prevent complete emptying; the tops are ground perfectly flat to allow the use of a slicker plate and the shape is such as to allow liquids to be readily poured from them. The measures are tested by verifying the amount of distilled water contained, correcting for temperature, barometric pressure and the expansion and contraction of the material.

These requirements and many others necessarily increase the cost, but the sealer who buys from us may be assured that our apparatus represents the highest grade of accuracy, permanency and durability possible.

Each instrument we manufacture is marked with our name which means, as it has for the last sixty five years, made on honor, sold at a reasonable profit and guaranteed accurate.

We are pleased at all times to be of assistance to sealers or to anyone interested in the subject of accurate weights and measures and a request for information in no way implies obligation.

W. & L. E. GURLEY,  
Troy, N. Y., U. S. A.

## HISTORICAL

Since the existence of society, weights and measures have been used in the exchange and barter of goods. In the earliest times, these took the form of similar pebbles, grains, or vessels. Each tribe had its own rough standards, those of the chief or tribal head being larger than the others when receiving tribute.

Intercourse between tribes and nations having different standards resulted in general confusion. A systematizing and adjusting of the measures was attempted, but the only far reaching reorganizations have been brought about during the last century. A great deal is yet to be done to bring about international uniformity.

It is not necessary to enter into a discussion of ancient standards, as their values are largely a matter of conjecture. There existed in Greece and Rome, however, a system of inspection which we have every reason to believe was a great deal better than that in many cities and States of the present time.

The middle ages afford nothing of interest on this subject.

The first step of any value was made in 1795, when the French, realizing that their measures were in an extreme state of confusion, devised and adopted an entirely new system. The meter was made the standard of length and all other units were based on this. The whole system was rigidly decimal, and was called the "Metric System." A great deal of thought and accurate work was put upon this new system, and various conferences were held. In 1870, the French Government invited all countries to send representatives to consider the advisability of constructing new standards. A second conference, in 1875, resulted in the establishment of the International Bureau of Weights and Measures. Since that time, many of the nations have adopted the metric system; others have made it permis-

sive; and it will probably soon be universally adopted and made compulsory.

England has attempted to improve its system of weights and measures by reorganization, rather than by adopting an entirely new system. This change was made in 1824, when the imperial gallon containing ten pounds of water and the bushel containing eight gallons were adopted. A new pound weight was made in 1869, and in 1878 the Troy pound was abolished.

Canada has changed her English system to a decimal one.

The history of the weights and measures of the United States is excellently outlined in the paper by Mr. L. A. Fischer in the proceedings of the "Conference on the Weights and Measures of the United States," published by the Bureau of Standards, Washington, D. C., 1905. The early weights and measures of the United States were of English origin, having been mostly copies brought over by colonists. As the measures of England were not standard, the copies showed wide divergence. According to the Constitution of the United States, Article 1, Section 8, Congress has the power to fix the standards of weights and measures, but, unfortunately, it has rarely exercised this power, leaving the matter largely to the individual States.

In 1828, the Troy pound was adopted for the Philadelphia mint as a standard of coinage. This brass pound was procured by Minister Gallatin and was received by President Adams.

The avoirdupois pound was derived from the Troy pound, to bring about uniformity in the custom houses, large discrepancies having been found in the standards in use in the different ports. The Treasury Department adopted the yard of thirty six inches, an avoirdupois pound of 7,000 grains, a gallon of 231 cubic inches, and a bushel of 2,150.42 cubic inches. The yard was the distance between two marks on a bar brought from England and supposed to be identical with the English yard. The avoirdupois

pound was derived from the mint Troy pound, making it equal to  $\frac{7000}{7000}$  of a Troy pound. The gallon was equal to the old English wine gallon (abolished in England in 1824). The bushel was equal to the old English Winchester bushel (abolished in England).

In 1836, Congress passed acts to furnish each State with weights, measures, and balances similar to those made for the custom houses.

In 1856, copies of the new yard and avoirdupois pound were presented to the United States, and the new yard was then accepted as standard by the office of weights and measures.

In 1866, Congress legalized the metric system, giving tables of equivalents, and the Secretary of the Treasury was authorized to furnish each State with metric standards.

In 1890, the United States received copies of the international meter and of the international kilogram, which were distributed by lot to the various governments by the International Bureau of Standards.

In April, 1895, the international meter and kilogram, being far superior in permanency to the previous standards, were made the fundamental standards of length and mass in the United States, both for metric and customary weights and measures. It is important to note that the standards of the United States are different from those of England (in some cases varying as much as seventeen per cent.), and are based directly on the metric standards.

Legislation has been introduced in Congress during the last two sessions defining the size of containers such as barrels, boxes and crates, also authorizing the Bureau of Standards to issue specifications regulating the types of all weighing and measuring instruments. It is to be hoped that Congress will enact legislation on these matters, and also define the number of pounds per bushel of different commodities. This, if done, will be a long stride toward the establishment of a uniform system of weights and measures.

## DUTIES OF A SEALER

The laws of different cities and States vary in their definitions of the duties of a sealer of weights and measures; the name of his office indicating in a general way the duties to be performed.

The sealer should have the proper authority to enter any establishment, or to stop any person or wagon, and inspect any weights and measures which are used in the sale or barter of merchandise of any form. A badge of office should be worn, which should be shown when necessary.

Every sealer should be prepared to properly inspect, test, and seal any measure, bottle, weight, weighing machine, box, etc., that may be used in the transaction of business, and consequently, the accuracy and convenience of his standards and apparatus are of utmost importance.

A tour of inspection should be made at regular and irregular intervals, and measures not readily tested on the premises should be sent to the office of the sealer for such testing.

Further, the sealer should be ready to inspect and test measures of any kind upon the request of a merchant or upon the complaint of a customer, and also for evidence in court.

In addition to the testing and sealing of weighing and measuring devices, the sealer should use his best efforts to see that these devices are used properly and that packages, pails, etc., contain the required quantity. This is of prime importance, for if full weight or measure is not given, the results of the inspection are entirely lost. The weight of containers, such as butter dishes, bags, wrappers, etc., should be noted, also whether or not they are included in the weight of the commodity bought or sold. All improper methods of weighing or measuring should be prohibited.

In order that the sealer may be sure of his tests, he

should compare at intervals, possibly monthly, his working standards with his office standards, and periodically the State Sealer should inspect the local sealer's outfit and make the necessary alterations or corrections, or have them sent to a responsible manufacturer of sealer's apparatus for repairs, and to the State Department of Weights and Measures or to the National Bureau of Standards for verification.

## EQUIPMENT

The equipment of a sealer of weights and measures will vary in different localities, according to the nature of the business or manufacturing interests; and it may be more or less elaborate according to the size of the community and the laws of the locality or State.

There is, however, one imperative condition: *The sealer's standards must be carefully and accurately made, or his tests will be of no value.*

The equipment may be divided in two parts: (1) the Office, and (2) the Apparatus.

### OFFICE

A suitable office and storeroom should be provided, the latter being necessary for the preserving of records and the temporary keeping of condemned measures. The suggested floor plan on page 12 shows the least space that a sealer should be content with.

It should have the following furnishings:

A cabinet (No. 9675, see page 103), the upper part of which may be used for a large testing balance (No. 9570), and length and weight standards, for which shelves are provided; the lower part for the keeping of capacity and other standards.

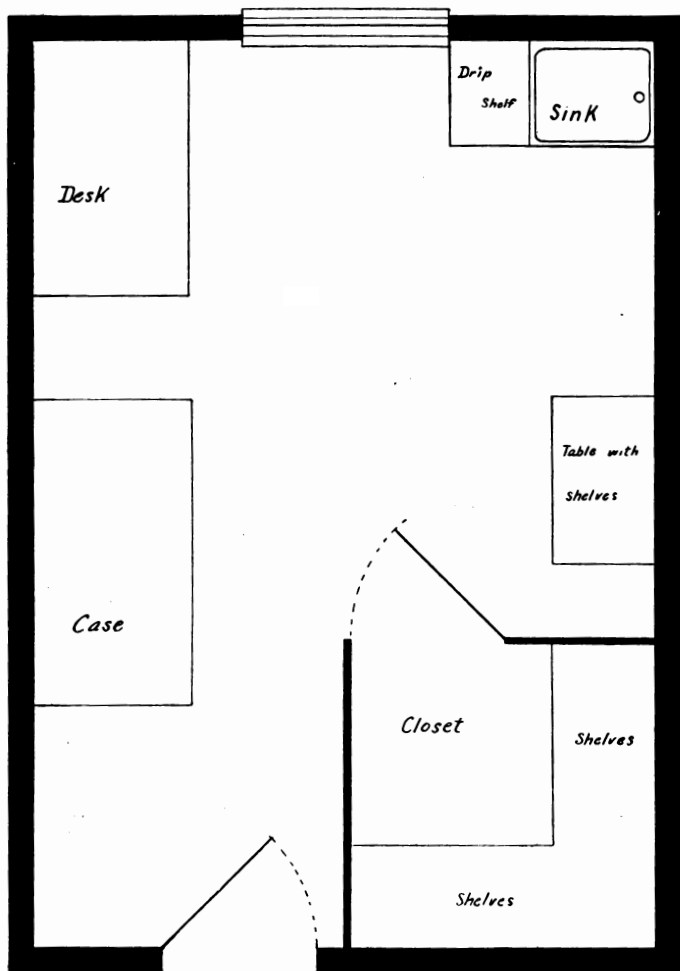
A sink with water connection and a drip shelf, for testing liquid capacity measures. The sink should preferably be of slate or soapstone, and of sufficient depth, about twelve inches, to cover the measures with water.

A box for small grain or beans to be used with the Hopper Funnel (No. 10041-10042), in testing dry measures.

A shelf on the wall for a small balance (No. 9591).

A tripod with hook for hanging scales while testing (No. 9546).

A table with shelves, or a chest for tools, etc. (See



pages 136, etc.) The table or workbench should be provided with a vise, a sealer's anvil and straightening iron, and a small vertical drill similar to No. 10279.

A desk and necessary chairs.

### SEALERS' APPARATUS

As already stated, the standards are the most important part of the sealers's equipment and it cannot be too strongly emphasized that they must be not only carefully constructed but accurately adjusted and easily and conveniently handled. The apparatus should comprise the following:

(a) A large Office Balance for testing and adjusting weights up to fifty pounds or twenty five kilograms. This should be so constructed that when arrested no knife edge touches its corresponding plane or bearing. It should have beam, hanger, and pan arrestment. The central support should be stable. A balance, where the pans are simply hung from the ends of the beam, will soon become insensitive, due to the blunting of the edges. Figure 9570 shows a balance well suited to accurate work. The planes are of agate, the knife edges of hardened steel, and the beam of aluminum. When the crank is turned to the right, the beam with the knife edges is raised and there is no wear when the balance is not in use. The beam is provided with adjusting screws on each end. A mirror back of the ivory index greatly facilitates readings.

(b) A small Office Balance for calibrating and adjusting small weights, from one half pound or two hundred grams down. This balance should be provided with agate edges and planes and with a rider for the beam. It should also have a glass case with a sliding door. A balance for this purpose is listed and described on page 101.

(c) A Portable Balance of about ten pounds or four kilograms capacity. This should be as compact and light as possible, yet rigid, sensitive and easily set up in any place. The pans should be slightly concave or provided

with a rim so that small weights or shot will not roll off. On page 99 is illustrated a balance meeting these requirements. The beam is of aluminum and the pan of thin metal with turned rim, to give rigidity and lightness.

(d) Forty fifty pound weights, or forty twenty five kilogram test weights (page 92), for testing large weighing machines, as hay, wagon, cattle, or railroad scales. These may be made of steel or iron. One necessary qualification is that they be so made that they shall not easily catch dust, dirt, or snow.

The ordinary weight with a lead plugged hole in the bottom is valueless as a sealer's standard.

(e) A Set of Weights from fifty to five pounds, or from twenty five to two kilograms, for testing small platform, counter, and spring scales. (See page 89.)

(f) A Set of Test Weights consisting of two two-pound weights to one sixteenth of an ounce, or of two one-kilogram weights to one gram, for testing small commercial weights or small counter balances. (See page 82.)

(g) A Set of Fractional Grain Weights or Gram Weights (pages 84-86), for testing the sensitiveness of balances.

(h) A Standard Length Measure, divided for thirty-seven inches into thirty-seconds of an inch, or for one hundred and one centimeters into millimeters, or both. The measure should be arranged with a fixed stop at one or both ends. (See pages 68-70.)

(i) Liquid Capacity Measures, from one gallon to one gill or from four liters to one deciliter. These must be of rigid construction, particularly the bottom, which should not be made of very thin sheet metal without having strengthening ribs. (See pages 106-113.) The top should have a smooth flat rim, in order that a "slicker" plate may be used.

(j) Dry Capacity Measures, from one half bushel to one pint, or from four dekaliters to one half liter. These test measures should be cylindrical in shape with

a rigid bottom and rim. The top should be smooth, in order that a "slicker" plate or striking stick may be used. (See pages 114-116.)

(k) A Hopper Funnel (see page 117) suitably mounted and provided with a metal cut off, to be used in testing dry measures.

(l) A Dry Measure Gauge, for measuring the depth and diameter of dry measures. (See page 120-121.)

(m) Steel Letter and Figure Dies, for sealing weights, measures, and scales. (See page 122.)

(n) Steel Dies, for stamping condemned measures, etc. (See page 123.)

(o) A Rubber Stamp, for marking glass bottles with glass ink. (See page 127.)

(p) Printed Gummed Labels, for marking balances and scales. (See page 142.)

(q) Glass Ink, for marking glass vessels, such as milk bottles, glass measures, etc. (See page 127.)

(r) A Combination Drill and Clamp with the necessary drills, to be used in adjusting weights. (See page 131.) This may be screwed to a table or wagon bed or fastened with the clamp to any shelf or counter.

(s) A Lead Covered Anvil or stake iron. (See page 125.)

(t) A Sealer's Kit of tools. (See page 136.)

On a tour of inspection the scaler should take with him the following apparatus:—A portable balance (see page 99); a set of small weights two 2 pounds to 1-16 ounce (see page 82); a set of large weights 25, 10, and 5 pounds (see page 89); when necessary, forty fifty-pound weights (see page 92); small dry measures (see page 116); set of liquid measures (see page 111); dry measure gauge (see pages 120-121); standard length measure (see page 70); or 6 ft. steel tape (see page 72); dies (see

page 122); gummed paper seals (see page 142); sealer's tool kit (see page 136); a sealing clamp or anvil (see page 125); a copy of the laws of his locality which refer to weights and measures and their inspection, and a copy of this HANDBOOK.

If the sealer is not provided with a horse and wagon, he will find it advisable to carry this apparatus in a convenient case (pages 94-98) when testing the smaller scales and measures.

The above list includes those articles which are absolutely necessary, but by no means all that he should have. A sealer can never have too many standards. He should certainly have customary and metric weights and measures as well as Troy weights for testing bankers', jewelers' and apothecaries' weights.

It is essential in all cases to have office standards separate and distinct from the working standards.

## GENERAL RULES FOR TESTING AND SEALING

Great care should be used in testing weighing and measuring apparatus, as the sealers' judgment should be final. A decision should not be given unless the sealer is absolutely sure of the test, and this having been made, it should not be reversed. A sealer is the only officer to decide whether or not a scale, weight or measure is accurate, and his judgment can only be set aside by appeal to the courts. He should be personally sure of the accuracy of his equipment and being so, he is in a position to reject as inaccurate, all scales, weights and measures which do not conform to his standards.

The standards should be kept clean and in good condition. The fact that they are rusty and worn will leave an impression that the tests are not accurate. Many of the stores at the present time are equipped with weighing and measuring apparatus which will compare favorably with that of the sealer, and unless the sealers' standards are the best obtainable, the public will have no confidence in his tests.

When entering a place of business for the purpose of inspection, the sealer should invariably send his card to the person in charge. In some cases, however, especially on irregular inspections or complaints, this can be deferred. Note should be taken of the manner in which the scales, etc., are being used, weights of different commodities put up for sale, etc., with the object of correcting any improper methods and securing full quantity to the purchaser.

Tests should be made slowly and the sealer should not allow himself to be hurried in any way. A close inspection of the article should be made before testing and its condition noted with reference to loose or missing parts, whether or not it is balanced properly, etc. Scales should be placed upon a fairly level base

and should not be exposed to a current of air from ventilating fans, doors, etc. Pieces of metal, hooks, paper memoranda, or loose articles of any kind, should not be allowed to hang on the scales, and all poise set screws should be riveted on the end and not removable.

It should be remembered that most weighing and measuring instruments of any reliable make are tested for accuracy before being placed upon the market, and if they should fail to pass the sealers' test, the fault can be readily found upon examination. This fault should be explained to the owner, that he may decide whether repairs or a new instrument are desired. The manufacturer of a reliable instrument will always put his name on it, and the quality can always be judged from this fact.

Generally speaking, the sealer should not make extended repairs on scales unless he has a practical knowledge of the trade. All of the better scales are provided with devices to adjust any error caused by ordinary wear, etc. Should the error be too great to be corrected by these devices, the scale should be sent to an expert for repair. Any adjustments which involve bending the beam or straining the parts should not be undertaken by the sealer.

The same can be said in regard to sharpening pivots. This requires the use of certain gauges, etc., with which the ordinary sealer is not equipped. However, if it is found necessary to remove the pivots, it is well to remember that they are to a certain extent wedge shaped, and should be driven toward the larger end.

The sealer should be familiar with the principles on which scales are constructed. A knowledge of these having been obtained, he will find that errors can be seen and corrected, and scales can be tested accurately and easily.

When making tests, the dealer's interest should be kept in mind, as well as that of the public, as it is the sealer's duty to protect both. A scale, for instance, should be tested to find the lowest weight necessary to throw the pan or cause a movement of the indicator. If this is exces-

sive, in the sealer's judgment, the scale should be condemned as not being sensitive enough for the purpose employed. A good rule to follow is to call the dealer's attention to any fault the sealer may note in regard to his instruments or his method of weighing or measuring. In most cases this is appreciated and the sealer's instructions are followed.

In regard to the testing of dry measures by the dry measure gauge, it should be noted that while for all practical purposes this is the best and easiest method for outside testing, the only legal method is to compare them directly with the standards, using water or a hopper funnel. In all cases where the sealer expects to take legal action, the latter method should be used. Evidences of fraud in wooden dry measures can usually be plainly seen, bearing in mind that the lap is always machine nailed and the bottom secured by wooden pegs. Any signs of re-nailing or alteration should be cause for suspicion and a thorough examination made. Stacking the measures—that is—placing the commodity in the measure so as to leave a large amount of open space and thereby not giving the full quantity, should not be allowed. This occurs frequently in a city where measures of a small diameter are used. Whenever possible the use of peach baskets by hucksters and peddlers for measuring should be prohibited. This is one of the most common forms of giving short measure. It is recommended by most of the State Departments of Weights and Measures that the hucksters, junk dealers, etc., submit their scales and measures to the sealer for inspection, before securing a license or permit to do business.

Liquid measures should be thoroughly cleaned before testing. If a one quart measure has a middle ring denoting one pint, this ring should also be tested. It should be noted whether the bottom springs down when the measure is filled, as such springing will cause a serious error. Do not allow liquid measures to be used for meas-

uring dry commodities or vice versa. Paint measures should be cleaned by being placed in a solution of potash once a week or oftener if required. Both paint and molasses measures should be turned mouth downwards after using, to thoroughly drain.

As there is no weighing or measuring instrument made that is absolutely accurate, the amount of tolerance the sealer shall allow is a difficult question to decide. In general it may be said that the sealer should use his best judgment on tolerances, taking into consideration the value of the commodity which is weighed or measured by the instrument. It is obvious that if a scale is used in weighing a commodity worth \$2.00 per pound, it should be tested to a finer degree and condemned if it does not respond to a smaller test weight than a scale used in weighing a commodity worth \$.05 per pound. In this connection the sealer should not allow too coarse a scale to be used in weighing the higher priced commodities at retail. A spring scale upon which the smallest graduation is  $\frac{1}{4}$  pound should not be used for weighing butter by the pound.

Tolerance or allowable error tables for the weights and measures will be found on pages 148-151. These should be used as a guide when testing unless contrary to the local statute or State Department specifications.

It is advisable that the sealer note in a small book all suspicious circumstances and violations of the weights and measures laws, which should be transferred to the office records. These can be referred to at any future time and will be a great aid in prosecutions.

By observing the foregoing general rules and the methods of testing as outlined on the following pages, the sealer will have the respect of both the public and the dealer in his work and the testing can be performed accurately and quickly.

## LINEAR MEASURES

Linear measures may be divided in two classes, each with subdivisions:

1. Rigid Measures.

- (a) One-piece non-metallic end or line measures.
- (b) " " metallic " " "
- (c) Folding non-metallic " " "
- (d) " " metallic " " "

2. Flexible Measures.

- (a) Tapes of metal or cloth.
- (b) Chains.

Any measure of whatever type should be made in such a manner and of such material that, under ordinary conditions, variation in its length will not exceed a certain allowable error or tolerance. (See page 148.)

### RIGID MEASURES

**Inspection.** All warped or bent measures should be condemned. All non-metallic measures without metal end pieces should be condemned.

All measures should be permanently and clearly marked by engraving, etching, or stamping, and the length of the measure should be definitely indicated.

Folding measures should be so constructed that the joints come to a definite position when opened.

Metallic measures should be carefully ground flat and straight.

**Testing.** Linear measures are to be tested by comparison with the standard measure.

End measures are laid on the sealer's standard between the stops or with one end against the end stop, the position of the other end is then read on the standard. If the allowable error is not exceeded (refer to the table of tolerance, page 148), it should be sealed.

A yard measure should fit between the two end

without too much shake. With a little experience the sealer can easily estimate this.

The six foot steel tape (9156) which is graduated at the yard and its fractions, may be laid evenly on the measure to be tested and the variations noted.

Line measures are laid beside the standard and the variations noted. A number of intermediate dimensions taken at random should be compared. If the amount of error is to be more carefully determined, a close reading may be taken by using the small vernier (see page 69) in connection with the standard. Still closer determinations may be made by using the comparator, which should be in the office of the State Sealer, or by sending the measure to the National Bureau of Standards for comparison.

**Sealing.** When the measures have been tested and found satisfactory, they should be sealed by stamping with a steel sealing die (see page 122).

### FLEXIBLE LINEAR MEASURES

**Inspection.** Only tapes made of metal or of cloth interwoven with wire and rendered waterproof, should be accepted.

The beginning and end divisions should be clearly defined and should not coincide with the end of the ring or handle.

Chains should be made of steel with brazed links, and in every case the length should be clearly marked on the handle.

**Testing.** Tapes are tested by laying them on the standard measure or on a standard bar (see page 71), which should be in possession of the State Sealer. They may be verified also by laying on the floor beside a standard steel tape (see page 72) and the points of coincidence carefully noted. If the variations are greater than the allowable errors (see page 148) the tape or chain should be rejected.

The tension or stretching force may be measured by a spring balance and is approximately fifteen pounds for

chains, ten pounds for steel tapes and two pounds for cloth measures.

**Sealing.** Steel tapes should be sealed by etching as follows: Slightly warm the tape and cover a small part with paraffine. Cut with a sharp tool or needle whatever design you desire, through the wax. Then put a small quantity of diluted nitric acid on the wax and it will etch the part of the steel exposed by the pointed tool. Let it remain for ten minutes and remove wax. Do not allow the acid to touch the hand.

## WEIGHTS

For convenience, commercial weights may be classed as follows:

1. Ordinary Commercial Weights.
2. Jewelers', Apothecaries', and Bankers' Weights.

### ORDINARY WEIGHTS

**Inspection.** These weights should be so constructed as to give evidence that they will not be seriously affected by atmospheric conditions nor by the usual handling. They should be made of iron, painted or plated; of steel, painted or plated; of brass, or of any substance of like hardness.

Weights should not present any sharp corners or angles liable to be easily worn or broken, or any places which would easily retain dust or dirt. Lead weights, unless encased in brass, copper, or like material, should not be allowed.

Weights larger than five pounds, or two kilograms, should be provided with handles, cast, screwed or driven in, without the use of lead or other binding material. Weights under five pounds, or two kilograms, may be with or without handles.

Weights less than one quarter ounce, or ten grams, should not be made of iron. When weights are adjusted by means of a lead plug, it should be firmly imbedded in the hole provided and be at least one sixteenth of an inch, or one millimeter, below the surface of the weight. All weights should be clearly marked with figures of appropriate size to designate their weight.

**Testing.** Weights of ten pounds, or four kilograms or less, should be tested by comparing them with the working standards (see page 82), making use of the portable balance (see page 99), which may be operated on any bench or counter. To set up balance No. 9560, raise the top, lift

out the beam with suspended pans and hang it on the hook.

If the weight does not come within the allowable error, as given on pages 150 and 151, it should be condemned and confiscated; or if the sealer sees fit, he may adjust it by using the portable balance, drilling the necessary holes in the weights by means of the portable drill (see page 131), and if necessary adding lead, being careful to drive it in firmly with a punch (see page 131). If the weight is too thin to retain the lead, drill the hole clear through the weight and rivet the lead on both sides.

Great care should be taken in testing platform scale weights. These should be adjusted to a degree as fine as the sealer's testing balance will allow. For instance: the leverage on a wagon scale being usually one thousand to one, an error in the weight of one half ounce will cause an error in the draft being weighed of five hundred ounces or thirty one and one quarter pounds.

Weights over ten pounds, or four kilograms, may be taken to the office of the sealer for verification, where the large office balance (see page 101) is available, or in an emergency they may be tested by making use of the large weights and an ordinary balance that has been tested and sealed.

**Sealing.** Weights found satisfactory are sealed by stamping the initial of the town or county and the year with a steel die (see page 122) on the top of the weight and on the lead plug, if it be exposed. Condemned weights should be confiscated and destroyed.

### **JEWELERS', APOTHECARIES', AND BANKERS' WEIGHTS**

**Inspection.** These should be made of brass, bronze, platinum or aluminum. The knob may be screwed, driven or cast in the weight. In other respects the same precautions are to be observed as for ordinary weights (see page 24).

**Testing.** As these weights should be more carefully adjusted and tested than the ordinary store weights, it is better that the sealer should take them to his office and adjust them on his large or small balance (see page 101). In case the sealer is in doubt, he should send the weights to the State Sealer or to the National Bureau of Standards, for, if the sealer is not prepared to seal these weights, he had better not undertake to do so.

**Sealing.** Whenever possible, each weight should be stamped on its top surface with a steel die.

## BALANCES AND WEIGHING MACHINES

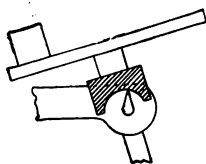
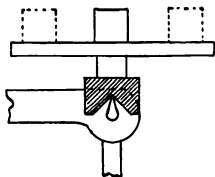
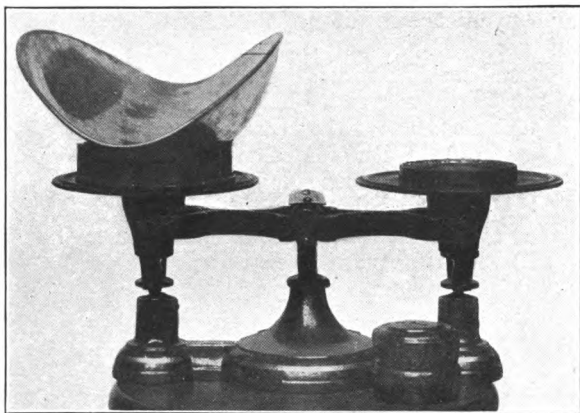
For convenience in discussion, balances may be divided as follows:

1. Equal arm balances
  - (a) Load suspended below the beam
  - (b) Load above the beam
    - (1) With side beam
    - (2) Without side beam
2. Unequal arm balances
  - (a) Load suspended below the beam
  - (b) Load above the beam
  - (c) Compound lever type
3. Spring balances
4. Computing scales
5. Torsion balances

Type 4 may be of any of the preceding forms or a combination of them, together with some computing device more or less automatic and more or less complicated.

### EQUAL ARM BALANCES WITH LOAD BELOW THE BEAM

**Inspection.** The beam should be symmetrical about the central supporting knife edge. All knife edges are to be sufficiently hard to withstand a file. They may be of agate or steel, and should be firmly attached. The bearings may be of chilled iron, agate, steel, or other like hard material. The bearings or knife edges must also be separately attached and not be simply a hardened part of the beam, because in such cases the part immediately adjoining the hardened portion becomes damaged in quality even though it is not outwardly apparent. Adjusting screws should be locked or covered and attached in such a manner that they will require the use of an outside mechanical device to operate them.



The central support should be rigid and firmly fastened to the counter or supporting base. Balances of this type may be hung over a hook with a pointer projecting upward, or may be supported by a central pillar with the pointer projecting downward or sidewise.

**Testing.** First see that when both pans are empty the pointer indicates zero or vibrates an equal distance on either side of the zero when in equilibrium. Place equal standards in each pan, equal to about half the capacity of the balance. Make the balance vibrate through a considerable arc and observe if it recovers itself rapidly, and whether the pointer comes to the same position as when there is no load on either pan. If this test is satisfactory, determine by means of the small weights, namely, the fractions of an ounce, grains or metric weights, how much is required to cause a decided movement of the pointer. This weight should be at most one five hundredth of the maximum load of the balance.

**Sealing.** If the balance is found satisfactory, a gummed label seal (see page 142) may be placed in a conspicuous place on the support of the balance, or it may be marked with a steel die if a special place is provided therefor. Sometimes difficulty is experienced with gummed seals by their not properly adhering. This is due to the presence of grease on the parts of the balance and the difficulty may be entirely overcome by wiping the place where the seal is to be attached with a cloth moistened with a soda solution. Often it is convenient to attach a wired lead seal (see page 128). In no case mark the beam unless a place is specially provided for such marking.

### **EQUAL ARM BALANCES WITH LOAD OVER THE BEAM**

**Inspection.** These balances may be with or without a side beam. Inspect the knife edges and bearings as described on page 27. The balance should in no case have a scoop with a corresponding counterpoise. If a scoop is used it should form a part of the balance. All balances of

the form shown in the figure on page 28 should be rejected, because the simple omission of the separate counterpoise for the scoop introduces a serious error.

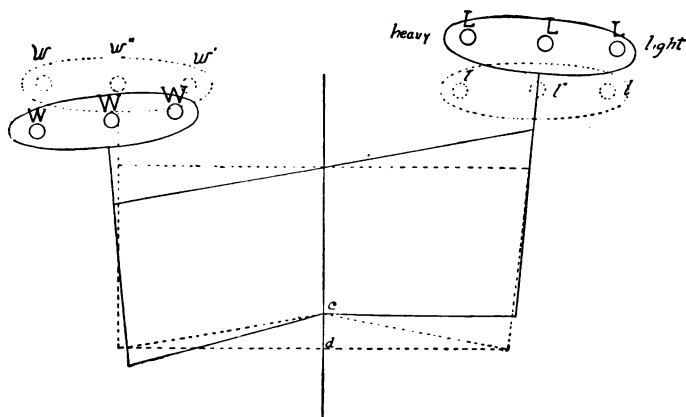
Most of the equal arm balances now in use are so constructed that the lower connecting rod is in two pieces, with the joint adjustable in height. In some cases the beam and the connecting or tie rods are not parallel, and the balance will give varying results, depending on the position of the weights and goods on the pans. (See page 31.)

The center fulcrum should be rigid and the bearings clean and free from dirt. If equipped with agate bearings, the agates should be set firmly in their bed. Both bearings and pivot covers should be smooth and present no rough surfaces. Check or tie rods should not be bent. Do not use oil of any kind on a pivot scale as it serves to collect dust and dirt and will not improve the action of the scale.

If a side beam is affixed to the beam, the divisions should be equally spaced and the sliding poise should not be removable from the balance. The side beam should have a shoulder on the end, so that the hanging poise cannot be slipped past the zero mark.

**Testing.** Tests for balances of this type should be made according to the instructions given on page 29. In addition, place equal standards in the center of each platform pan, or weight plate, then shift one to various parts of the platform; if the balance is properly constructed equilibrium will exist wherever the weight is placed on the plate. The sensitiveness should be at least one five hundredth part of the maximum load. The two pans may generally be unscrewed, and if there is a lack of balance due to the unequal weight of the two arms, they may be balanced by adding or taking out lead from the cup under the pans.

**Sealing.** If satisfactory, affix a gummed label seal in a conspicuous place on any of the rigid parts of the balance or attach a lead seal.



The figure shows an equal arm balance with the central spindle which connects the tie rods raised from  $d$  to  $c$ , thus destroying the parallelogram on which the balance depends for its accuracy. The dotted lines show the position of the distorted balance in equilibrium, the solid lines the balance out of equilibrium. An inspection of the diagram shows that if a weight is placed at  $W$ , it will descend through a greater distance than a load placed at  $L$ , thus giving  $W$  a greater influence; placing a weight at  $W'$  and the load at  $L$  gives  $L$  a greater influence; when the weight is placed at  $W''$  and the load at  $L''$  the effects *may* be equal.

The operator has it in his power, in this case, to weigh light or heavy, depending on the position of the weight and the load in the pan. If the weight is placed in the center of one pan, and the load on the outside of the other, it will weigh light; if the load is on the inside of the other pan it will weigh heavy.

### UNEQUAL ARM BALANCES WITH THE LOAD SUSPENDED BELOW THE BEAM

This includes all scales consisting of a single beam with hooks or pans attached to the short arm. The heavier type are usually set in a frame with a down haul to raise the load from the ground.

These large scales are usually graduated on both sides of the beam, the heavier side having a capacity of four times the lighter. Removable hanger poises of a definite weight are provided and are generally of an even number of pounds, such as 2, 4, 8, 16, etc., this being marked on the side of the beam.

**Testing.** Balance the beam by means of the ball at the end of the short arm or in some cases by the hollow hanging weight at the end of the long arm. Assuming that the scale under test is stamped on the lighter side 4 lbs. and on the heavier side 16 lbs., hang a 50 lb. test weight in the hooks and set the one pound hanger weight (10275) in the notch on the light side of the beam marked 200 lbs. Repeat the operation at different points, using test weights equivalent to one fourth of the indicated graduation on the beam. If the results are satisfactory, test the poise weights on the small portable balance (9560.)

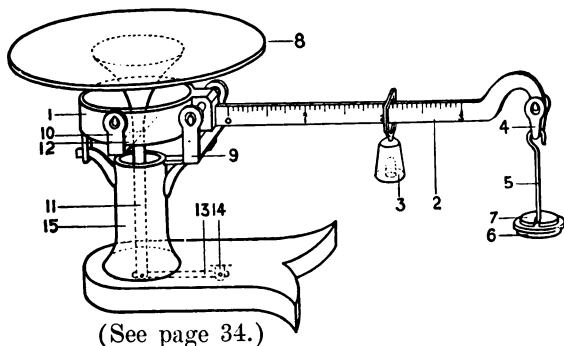
Or, attach a wooden platform to the short arm of the scale by means of ropes or chains and balance the beam with lead hung at the end of the long arm. Place test weights on the platform, as near to the amount of the indicated capacity of the scale as possible, and note the result as indicated by the poises. These poises can usually be adjusted by adding or removing shot, for which purpose a small hole is generally provided on the under side of the poise secured by a screw.

The knife edges on the poises should be sharp and work freely in the notches. Scale pivots should be sharp, the bearings smooth, the beam graduations regular and clearly defined. The beam should have a regular, even motion whether with or without a load.

Test for dulled pivots or worn bearings in the following manner: Place a load of about the indicated capacity of the scale on the hooks and weigh it three or four times, releasing the down haul each time and letting the load rest on the floor. If there is any change in the indicated weights, the scale is incorrect. When fully loaded, add small weights until the beam rises. If the amount of added weight necessary to throw the beam is excessive, the scale should be condemned.

Steelyards of the vibrating type should be tested by hanging test weights in the hooks and sliding the poise back until the beam vibrates. For instance: hang a 10 lb. grip weight on the hook, set the poise at a point three notches beyond the 10 lb. graduation and keep sliding it back until the beam vibrates. On this test the beam should vibrate only when the poise is at the 10 lb. notch.

**Sealing.** If satisfactory, attach a wired lead seal to a rigid part of the scale.



(See page 34.)

In a balance of the above form the parts are usually designated as follows:

1 Beam Head, 2 Beam, 3 Poise, 4 Counterpoise Loop, 5 Counterpoise Stem, 6 Counterpoise Cup, 7 Weight, 8 Plate, 9 Tall Bearing Post, 10 Short Bearing Post, 11 Cross Bar Post, 12 Cross Bar, 13 Check Rod, 14 Check Rod Holder, 15 Stand.

### UNEQUAL ARM BALANCES WITH THE LOAD ABOVE THE BEAM

**Inspection.** Inspect the knife edges and the bearings as described on page 27. These balances are generally provided with one pan and a poise (see page 33), which is read directly on the beam, as in the steelyard.

If a separate scoop with additional equivalent counterpoise is used, the balance should be rejected, as by the omission of this counterpoise an error easily arises. Examine the divisions on the beam, see that they are equally spaced and that the sliding poise is not readily detachable.

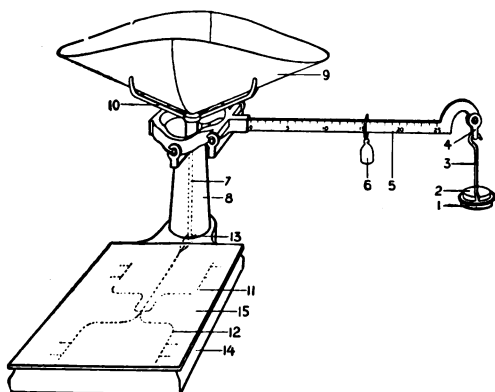
**Testing.** Place a known weight on the pan and produce equilibrium by the sliding poise. Note the reading, which should agree with the weight placed on the pan. No change of equilibrium should result, wherever on the pan or platform the weight is placed.

The divided beam must vibrate freely, and when disturbed must return to its normal position quickly and accurately. The pointer or beam should show a decided movement when a weight equal to one five hundredth of the maximum capacity of the balance is placed on the pan.

The leverage or ratio of the counterpoise to the pan or platform should be as indicated by the weights and is usually 1 to 4. If this leverage is not accurate, the scale should be repaired. Test the weights on the portable balance (9560) making them conform to the indicated leverage.

**Sealing.** If satisfactory, affix a gummed label seal or attach a wired lead seal to some rigid part of the balance.

## COMPOUND LEVER TYPE BALANCES



### Counter Platform or Union Scales

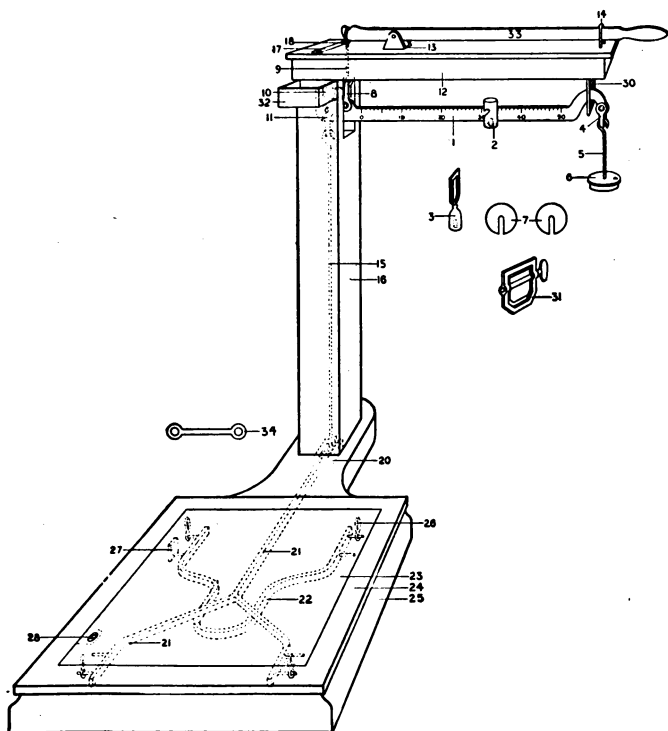
In a counter platform or "Union" scale the various parts are usually designated as follows:

1 Counterpoise Cup, 2 Weight, 3 Counterpoise Stem, 4 Counterpoise Loop, 5 Beam, 6 Poise, 7 Cross Head Post, 8 Pillar, 9 Scoop, 10 Cross, 11 Short Lever, 12 Long Lever, 13 Nose Iron, 14 Frame, 15 Platform.

## UNION SCALES

These should be placed on a level counter and the platform should be free and move easily. Lift the ends of the platform slightly to free the bearings and allow the levers to fall in their natural position. In the case of Union scales, the flat bearing on the under side of the platform should be nearest the beam. The ratio of the pan to the platform on Union scales is usually 8 to 1. Weights marked 5-40 indicate that they should balance 5 lbs. in the pan or 40 lbs. on the platform. If it has a single beam, this is graduated with two sets of figures, the under graduations denoting the weight on the platform.

**Testing.** Proceed in the same manner as in portable platform scales, with the exception that in Union scales



1 Beam, 2 Poise, 3 Bush Poise, 4 Counterpoise Loop, 5 Counterpoise Stem, 6 Counterpoise Cup, 7 Weights, 8 Fulcrum Loop, 9 Fulcrum Lever Beam Hook, 10 Balance Ball, 11 Beam Rod Loop, 12 Drop Lever Cap, 13 Fulcrum Lever Stand, 14 Fulcrum Lever Hook, 15 Beam Rod, 16 Pillar, 17 Strap Washer, 18 Pillar Rod Nuts, 20 Nose Iron, 21 Long Lever, 22 Short Lever, 23 Platform Board, 24 Platform, 25 Frame, 26 Loop and Link for Levers, 27 Bearing Block, 23 Screw and Block, 30 Cap Loop, 31 Trig Loop, 32 Drop Lever Cap and Weight Frame, 33 Fulcrum Lever, 34 Check Rod.

the platform leverage is generally 1 to  $53\frac{1}{3}$ . Therefore it is advisable to place test weights amounting to  $\frac{3}{4}$  lb. on the counterpoise against 40 lbs. on the platform or 5 lbs. in the pan. If the indicated ratio of the pan to the platform of 1 to 8 does not maintain, it may be adjusted by means of the nose iron, which is found on these scales of the better grade. If this fault is found and no nose iron is provided, the scale should be condemned. If for any reason the under loops holding the levers are removed by the sealer, care should be taken to place them in their original corners, as in many cases they are of different lengths. For convenience in replacing, these corners and loops are sometimes painted in different colors, such as red, white, blue and green.

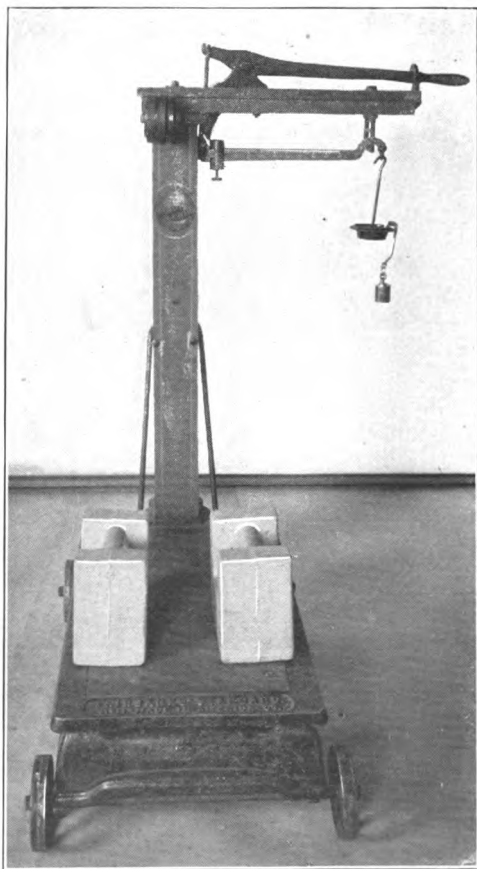
The platform should be removed and the interior cleaned. The levers on these scales are within a short distance of the counter and very often papers, dirt, etc., will gather underneath and cause inaccurate weighing.

If satisfactory, affix a gummed paper seal or attach a wired lead seal to some rigid part.

### PORTABLE PLATFORM SCALES

The general principles of portable platform scales are identical, though they may differ in some of the minor details. In some, the platform rests directly on the bearing pivots, in others the platform rests on balls which are set in a frame bearing on pivots, and other varieties have the platforms resting on frames suspended from pivots.

In the better known and usual type, the platform rests directly on the bearing pivots and is secured against displacement by four eye bolts, known as check rods. If the platform is moved to one side, these rods will tighten and thus affect the sensitiveness of the scale. Before testing a scale of this pattern, the platform should be lifted, one end at a time, which will allow the levers to fall in their proper positions, and so loosen the check rods. In some cases the platform will only rest on three pivots,



**Testing Scale by Use of Hanger Weight on Counterpoise**

causing it to tilt up and down. This condition is due to the fact that the bearing plates or pivots are not in a plane and will cause a serious error, as each lever should bear its proportionate part of the load. If when level, this condition exists, it can be remedied by placing a thin sheet of metal underneath the bearing plate. The same method can be adopted, if when the scale is loaded the platform rests on the frame.

If the pillar or the trig loop is loose, the four screws on the under side of the cap may be removed, the top board taken off and the bolts tightened. In some cases the beam will be found to bind against the side of the trig loop. This may be remedied by loosening the pillar rods and resetting the cap, turning it to right or left as needed.

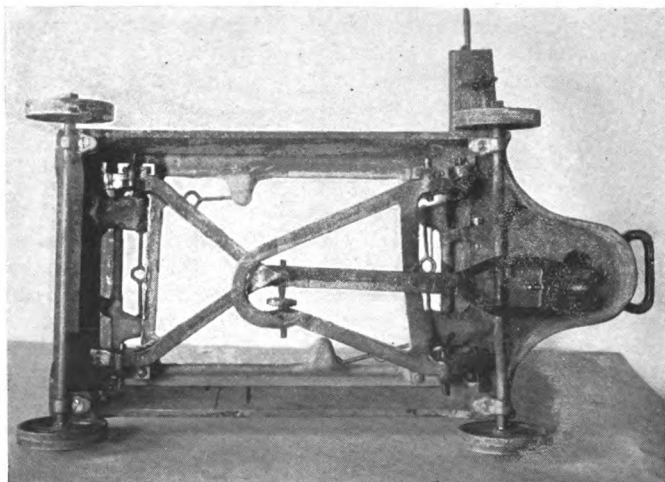
The scale being level and the levers hanging properly, the next step is to balance the beam. This can generally be done by means of the balance ball at the short arm of the beam. If the difference is too great to be taken up by the balance ball, remove the plug in the counterpoise at the opposite end of the beam and add or take away shot with which it is loaded. When a balance has been obtained, plug the counterpoise hole with a small piece of cork or wood. Some counterpoises are so made that when the cover is turned to the right or left, the hole is exposed. Care should be taken to leave the balance ball in the middle of the screw so that the weigher can balance the scale without recourse to the counterpoise.

These preparations having been completed, the testing can begin.

In regard to the method used, there is a difference of opinion among many sealers. The only absolutely sure method is to test to the full capacity with standard weights. This, however, is impossible in most cases. Some scales of this type have a capacity of 5,000 lbs., and if this method were used it would require the use of one hundred 50 lb. weights. The transportation and handling of this number of weights would be a hard problem for a sealer, especially in the smaller cities and towns.

If the scale cannot be tested to its full capacity, the so-called reduction method can be used. By this the leverage is determined by a smaller amount of weights being placed on each lever in turn.

The first step is to find the probable leverage. This is generally marked on the weights in this manner, 100 lbs.—1 lb. Place two 50 lb. test weights (page 92) on



**Scales Turned on Side, Showing Levers and Nose Iron**

one corner of the platform and hang a 1 lb. hanger test weight (10275) from the counterpoise or in the counterpoise loop at the end of the beam. This weight is constructed for this purpose and has a hook instead of a knob or handle, which makes it very convenient. If the leverage of 1 to 100 is exact, the beam should balance evenly. Repeat this test on each of the other corners of the platform and the same results should appear.

Should different results show on this test, it indi-

cates that the pivots are not the same distance apart. This can only be remedied by grinding the pivot edges, so that when tested with a fine gauge, there will be the same distance on all the levers. This is a long and exact process and should be undertaken only by practical scale makers.

If all the corners are equal and the leverage is more or less than that indicated by the scale weight, it can be corrected by moving the sliding nose iron situated at the lower end of the steelyard rod, which is the long upright rod encased in the wooden post connecting the lower system of levers with the beam.

For instance: The indicated leverage is 1 to 100. With the 1 lb. hanger weight at the end of the beam and 100 lbs. on the platform, the beam does not rise to a balance. Add weights to the platform until the beam exactly balances. The added weights will give the error in 100 lbs. Remove the platform and turn the scale on its side. With a nose iron wrench (page 132), loosen the under screw of the nose iron to the extent required to shorten the lever. Tighten the upper screw, which will move the nose iron, thereby making the lever shorter. Be sure that both screws are firm. Turn the scale back to an upright position and the under levers and hangers will be thrown to one side by the upsetting of the scale. Adjust these and replace the platform.

The scale will now need to be rebalanced, as any movement of the nose iron also changes the balance. After balancing, repeat the former test. This process may have to be repeated several times to get perfect results.

If, when the same test is employed, the beam should rise to the top of the trig loop and stay there, reverse the movement of the nose iron by loosening the upper screw and tightening the lower one. This will move the nose iron in an opposite direction, making the lever longer. Some nose irons are secured with an under bolt instead of screws. This bolt can be loosened and the nose iron driven in the direction desired.

The leverage now being adjusted, the beam should then be tested. To avoid probable error it should be tested to as near the indicated capacity as possible. An error of 1 lb. when the poise is on the 10 lb. notch becomes an error of 10 lbs. when at the 100 lb. notch. Try the poise at various points, and also observe whether the beam is graduated correctly.

If the poise is light or heavy, it can be adjusted by adding or removing lead. Most of these poises are made in two parts, one variety being held together with two screws, another having the upper and lower sections screwed together. Occasionally these screws loosen and drop out, especially in factories where there is a continual vibration. If only one screw is gone, lead can be added to replace its weight, one screw being sufficient to hold the two sections of the poise.

Often the set screws which are attached to some of these poises drop out or are broken off. This will cause a large error which can be corrected with lead. The best plan is to have the set screw riveted or upset on the end so that it cannot drop out. Any considerable amount of lead added or removed from the poise means a change in the balance and must be allowed for.

A good method of loading a poise is as follows: Assuming that the capacity of the beam is 100 lbs., place two 50 lb. test weights on the scale platform and set the poise at 100 lbs. Add lead by placing it on the top of the poise until the beam balances. Set the poise back to the zero mark, and after removing load from the platform, balance the scale again. Repeat this process until the addition of lead is so small that there is no change in the balance. Remove the poise and drive the lead into one of the holes in the under side of the poise with a small solid punch. (Page 131.)

Sometimes the poise is so battered that it will slide back past the zero mark. As it is a difficult matter to obtain a new poise and adjust it to the scale, the poise

can be removed and the points or indicators filed back so that when the poise is set against the heel of the beam, the indicator will point at the zero mark.

Be sure to add enough lead to the poise to compensate for the loss in weight caused by filing. If the beam is notched, the bearing edge of the poise should be fairly sharp, as a dull edge will make the scale less accurate, due to setting of the poise.

The scale now being correct, the weights should be tested. It having been ascertained that the 1 lb. hanger weight hung at the counterpoise exactly balances 100 lbs. placed on the platform, it follows that the scale weights should be adjusted to that ratio, the 200 lb. counterpoise weight to weigh 2 lbs. and the 500 lb. counterpoise weight to weigh 5 lbs. The sealer should have a small and sensitive balance for this purpose (see page 99), as any error in the weights would multiply 100 times,  $\frac{1}{4}$  oz. deficiency in the weight amounting to 25 oz. in the article weighed.

This test would not apply to the weightless or compound beam scales, where the capacity is represented on the beam. As there is no leverage to determine, the poises should be tested to as near the capacity as possible.

The sensitiveness should be determined on all scales. While the beam may balance evenly with a certain load, the addition or subtraction of considerable weight may make no perceptible difference. The amount of weight necessary to throw the beam should be regulated by the sealer's judgment, taking into consideration the use to which the scale is put.

Some of the more common faults are as follows:

Upon testing, the beam moved with a short rapid motion, indicating that there was an excess of friction somewhere. The poise on this scale could be set at 10 lbs. without throwing the beam up or down. Upon investigation, it was found that some stones had been placed in the upright post, which bound the steelyard rod. At other times small weights and even rats' nests have been found

in this convenient receptacle. In another case the same action of the beam was noted when a considerable number of weights were placed on the platform. This was caused by the pins supporting the hanging loops bending and allowing the platform, when loaded, to rest on the frame. This condition can also be caused by excessive wear on the pivots or bearing plates, or, in the case of dormant floor scales, by a screw working loose in the frame. In each of the latter cases, the under side of the platform will show the point of contact with the frame.

A scale upon test showed that the leverage, originally 1 to 100, had changed through no apparent reason. It developed that the end of the beam had been jammed against the wall, making the distance between the beam pivots shorter and causing considerable error. This was corrected by adjusting the nose iron.

**Sealing.** Attach a gummed paper seal or a wired lead seal to some conspicuous part.

### DORMANT OR FLOOR SCALES

These should be tested in the same manner as portable platform scales, using an amount of test weights in proportion to the capacity of the scale. The leverage is usually 200 to 1.

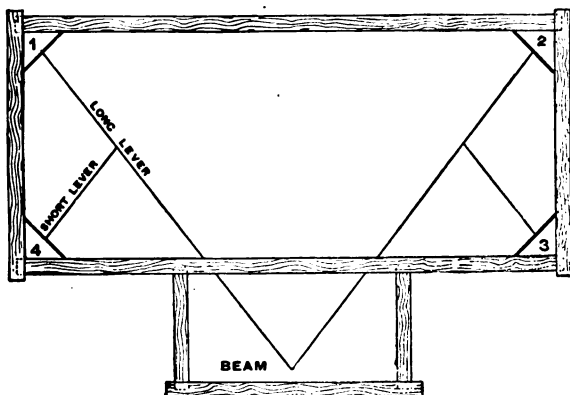
The platform should not bind on the floor at any point, the foundation should be solid and the frame and platform level. On account of the shallow pit in these scales, dirt, nails, etc., should not be allowed to collect under the levers or between the frame and platform. The screws holding the corner irons should be firm and not bind on the under side of the platform. The loop pins should be strong enough to support the maximum load without bending. The steel yard rod should work freely and not bind against the sides of the tube.

If satisfactory, affix a gummed paper seal or attach a wired lead seal to some rigid part.

### WAGON SCALES

A calm day should be selected for testing these scales, as the pressure of wind on the platform will cause the beam to vibrate rapidly and give inaccurate results.

Clean the edges of the platform from coal, stones, etc., with cleaning blade (page 135) and see that the platform



Plan of Wagon Scale Levers

does not touch the frame at any part. The platform should have a free movement, but not enough to allow the bearings to slide on the pivots. If it has no movement after freeing the edges, the check rods are probably too tight and may be lengthened.

Set the poises on the beam as far back as they will go against the step and in this position they should indicate exactly zero. If, on account of these poises being bent, they go past the zero, they may be unscrewed and the points filed back.

Balance the beam by means of the balance ball at the end of the short arm. If this is not possible, add or take

away shot or lead from the hollow counterpoise at the end of the long arm until a balance is obtained.

The leverage on these scales should first be determined. This is usually marked on the weights, two vertical lines indicating 2 lbs. to a ton, three vertical lines indicating 3 lbs. to a ton, etc. Assuming that the indicated leverage is 2 lbs. to a ton, place twenty 50 lb. test weights (page 92) on corner 1 of the platform (see illustration) and hang a 1 lb. hanger weight (10275) in the counterpoise loop at the end of the beam. The beam should then vibrate with a steady, even motion between the top and bottom of the trig loop. A quick, jerky motion indicates friction and that something is binding. The test weights should be placed in turn on corners 4, 2 and 3, and the beam should balance evenly at each point.

If inaccurate results are obtained, the working parts should be examined closely for defects. Dirt or coal may have sifted down and banked underneath the levers; the check rods may be too tight and hold the platform up; the bearing pins on the nose irons may have slipped from the loops or shackle; the beam rod connecting to the beam may be rubbing against the floor; the bearings may have slid over on the fulcrum pivots; the corner irons may have dropped a few inches; the pivots, bearings or pins may be worn or the foundation may have become unstable.

If the parts have been found in good condition and working freely, the levers may be adjusted if necessary. This is done by shortening or lengthening the lever in question by means of the sliding nose iron at the end of the lever, using nose iron wrench (page 132) and monkey wrench (page 132). If with 1000 lbs. on the platform and the 1 lb. hanger weight at the counterpoise, the beam remains at the top of the trig loop, then the lever is too short and may be lengthened, or vice versa. A little practice will enable the sealer to estimate the amount of adjustment necessary, bearing in mind, however, that any alteration of the levers will necessitate the removal of the

test weights from the platform and re-balancing the scale. As each lever carries its own nose iron, it is possible to adjust each lever in turn, always commencing with the long lever.

The poises should now be tested. These should be set at 1000 lbs. and the result noted. If they are too light through losing screws, lead, etc., enough lead may be added until the beam balances. As these poises are usually made in two parts, unscrew the under part and tamp the lead firmly into one of the holes with a punch (page 131).

The action of the scale under a fairly heavy load should be determined. Place a loaded wagon on the platform, weigh it accurately and add a known number of test weights. If inaccurate results are shown on this test, it denotes that some of the live parts of the scale are being strained and should be strengthened.

The sensitiveness of the scale should also be tested by adding small weights until the beam rises to the top of the trig loop. If the amount required is excessive, the scale should be repaired.

If the scale is equipped with a compound beam without loose weights, it will not be necessary to determine the leverage. If of the two lever pattern, the test weights should be placed across each end in turn.

Upright safety posts should be placed under the corners of all deep pit scales extending to within 4 inches of the heavy platform timbers. In case of breaking, the platform will then drop on these posts. The platform planks should always be level with the frame, as a sharp drop with a heavy load may cause the pivots or the ball plates to break. These planks should be sawed on a bevel and of a length sufficient to allow coal, stones, etc., to drop into the pit instead of binding between the frame and the platform.

A space of at least twelve feet on either side of the scale should be on the same level plane with the scale platform,

and all wagons should pass on or off the scale without turning to one side, as this will strain the parts.

If satisfactory, affix a gummed paper seal (page 142) or a wired lead seal (page 128) where it can be plainly seen.

### RAILWAY TRACK SCALES

Owing to the comparatively small amount of test weights the sealer can carry, the testing of these scales is a difficult matter. To produce the best results, a test car of at least 50,000 lbs. should be used whenever possible.

**Testing.** Clean out the space between the platform and the frame, using cleaning blade (page 135). See that the rails on the scale platform do not touch the outside rails. Sufficient space should be provided to allow for the expansion of the rails in warm weather.

Balance the scale by means of the balance ball at the short end of the beam. If in good condition, the beam should vibrate with a steady, even motion, without jumping. If the beam vibrates rapidly without touching the top or bottom of the trig loop, it indicates that some live part of the scale is binding against a dead part. The wind blowing across the platform will affect the movement of the beam and if blowing very hard, it is impossible to get accurate results. The poises should be set in the zero notches and care should be taken that the dog on the top poise is set snug into the V. In some cases, the spring on this poise is weakened and does not pull the dog into the notch. A smart tap with the hand is then necessary to set it accurately.

The scale now being properly balanced, the actual testing can be performed. A track scale usually consists of four sections, each with two platform bearings.

Forty 50 lb. test weights (page 92) should be placed on each of these sections in turn and the reading of the beams noted. By this method the full weight of 2000 lbs. is practically concentrated on each section and an

error is more easily detected. If an error is found in any section, it can be remedied by shortening or lengthening the middle extension levers by means of the nose iron.

An examination of the under levers should be made and the condition of the bearings and pivots noted. If dull or worn, the scale should be sent to a scale maker and repaired. The check rods should not bind, but they should be tight enough to prevent the platform bearings from sliding on the pivots. The condition of the foundation is a very important detail and this should be stable and strong enough to support the indicated capacity of the scale. The platform should not sink with a heavy load. If in doubt on this point, place a horizontal chalk mark on the side of both the outside and platform rails. Then run a heavily loaded car on the platform near the end and note if there is any drop.

If these tests show good results, weigh a freight car at both ends and also in the middle of the platform and note whether there is any difference in the reading on the beam. Then place small weights on the platform until the beam strikes the top of the loop. If the scale is sensitive enough to seal, 25 lbs. should throw the beam.

Some of these scales are provided with weights, and as the leverage is usually an uneven ratio, the weights can be tested in the following manner: Assuming that the weight is marked 20,000 lbs., place a freight car on the platform and set the heavy top poise in the 20,000 lb. notch. The remainder of the weight of the car can be taken up on the under poise. Place the 20,000 lb. scale weight on the counterpoise at the end of the beam, set the top poise back to the zero mark, and the beam should again balance. This indicates that the scale weight is the same as the poise, which has been previously tested and therefore is correct.

If satisfactory, a gummed paper seal (page 142) should be affixed inside the beam box or a wired lead seal (page 128) attached to the trig loop.

### COMPOUND SUSPENSION OR CRANE SCALES

These scales are used for weighing heavy machinery, large castings, etc., and are usually suspended from a crane, the load being attached by chains.

**Testing.** In most cases a large shallow box hung by chains is provided. Balance this box by means of the under beam on the scale, place test weights in the box and note the result. If a box or platform is not provided, select a heavy casting, weigh it on a platform scale that has been previously found correct and also weigh it on the crane scale.

If satisfactory, affix a wired lead seal to some conspicuous dead part of the scale.

## SPRING BALANCES

### DIAL SPRING BALANCES WITH HANGING PANS

The balances of this type used in the retail trade are usually of the capacity of 15, 30 or 60 lbs., the dial hand making three revolutions for the full capacity. The balance should be hung in a vertical position. If hung in a slanting position or backed against the wall, the slide will bind and affect the accuracy. The pointer should be neither too close to the dial to rub, or near enough to the glass cover to bind. They should be hung low enough to place the dial on a level with the eye. Loose pieces, such as hooks, papers, lead, etc., should in no case be allowed on the scale.

If the pointer does not set on the zero mark, it may be easily adjusted, in some cases by means of an adjusting screw. If none are provided, take off the glass cover, which is secured by means of fasteners bent over on the reverse side or by screws. If the pointer has a small screw in a slot at the tail end, loosen this screw with screw driver (10377), apply one jaw of the pliers (10385) on the screw head and the other jaw on the opposite side of the pointer. A slight pressure will cause the screw to move towards the end of the slot and thereby change the indication. If the pointer is of the small variety without screw adjustment, use pointer wrench (10314), the prongs of which are placed over the pointer at the center and turned to the right or left as needed. This will cause the pointer to turn on the brass center and it can be placed at any point around the dial. If it is desired to move the pointer to the right, the scale must be pulled down to its full capacity before using the wrench, and vice versa. The sealer should be careful and not exert too much pressure as it is liable to strain or bend the gear.

**Testing.** Place test weights on the pan,  $\frac{1}{2}$  lb. at a time, until the pointer has made one complete revolution, and note the indications. Then add 5 lbs. at a time until

the capacity is reached. Put on a 1 lb. test weight, pull the pan to 18 oz., and note whether the pointer will stay there. Repeat this at 14 oz. This test can also be made at different weights and will show whether or not the scale is sticking. If such is the case, it may be remedied, if the gear is not excessively worn, by removing the pointer with pointer lifter (10315), taking off the dial and cleaning the gear.

The following will cause serious errors: The rack and pinion gear may be worn; the lower end of the slide may be bent and not allow the pointer to come back to the zero mark; the rack may be bent, which will produce excessive friction at the heavy weights; the gear may be rusty or dirty and cause the pointer to stick; the dial may not be hung vertically and cause the slide to bind in the frame; some of the graduations may be rubbed off. Scales used for weighing fish should have perforated pans that water may not collect in the pan and cause errors. If the results of the test are not accurate, the scale should be closely examined for the above defects.

If accurate, affix a gummed paper seal or attach a wired lead seal in the ring hole at the top of the scale.

### STRAIGHT SPRING BALANCES

This is the ordinary type used by ice and junk dealers, hucksters, etc. and should be examined closely before testing. Scales of the sliding front type in which the face is not riveted firmly to the frame should be condemned. See that the pointer or the slide is not bent and that the upper support holding the spring cannot be altered. Also that there is not a piece of cork or other substance inside the frame, which will not allow the pointer to indicate the full capacity. In the case of ice scales, the head of the bolt holding the spring should not be worn enough to allow the pointer to fall past the zero mark when unloaded. Any alteration of the spring can

be detected by examining the rivets and noting if they have been removed at any time.

**Testing.** Hang on grip handle weights (page 89) up to the capacity of the scale and note the readings. Be sure that the scale is hanging in a vertical position while being tested.

If satisfactory, stamp on the brass face, near the edge, with a  $\frac{1}{8}$  inch steel die (page 122), or attach a wired lead seal.

### COMPUTING SCALES

These may be divided into two types, one of which has an indicator in the form of a barrel or drum and the other in the form of a fan.

In the barrel shaped type, the indicator should read the same on both sides. If not, the indicator frame on the customers' side may be removed and the pointer adjusted. To set the pointer on the dealer's side, raise or lower the scale frame by means of the set screws at the base, if on the pendulum principle. In the case of spring scales, remove the set screw cap which is found on the horizontal bar under the drum, and turn the set screw until the pointer and zero coincide.

The scale should not move too freely or stop too quick. This is adjusted in the platform type by means of a plunger and dashpot filled with oil or glycerine. Regulate by the set screw or the lever at the top of the dashpot. The hanging type is controlled by air chambers and plungers on the sides of the drum. These plungers may be taken out and cleaned if needed, but in no case should they be oiled. See that the scale index is on a level with the eye.

**Testing.** Place test weights,  $\frac{1}{2}$  lb. at a time, on the pan or platform up to 10 lbs., then 1 lb. at a time up to full capacity, and note the readings on the chart. Test for sticking as in dial scales. Place a weight on different parts of the pan or platform, but in no case allow it to project over the edges, and note the indications.

Practically the same test should be made on the fan shaped type. The pointer is adjusted by turning the set screw at the base of the frame, which changes the level of the scale. It is provided with a dashpot as in the platform type. If the weight indications are incorrect, the pendulum may be adjusted vertically on the lever. The poises on these scales should also be tested. Some of the scales of this type have a knob which, when turned, adds an extra weight to the pendulum. This doubles the capacity and is represented by red figures.

The following will cause serious errors: Covering the weight indications on either the dealer's or customers' side; removing the indicating line on either side; the indicating line on the glass not agreeing with the figures on the chart, that is, being high on one end and low on the other; the scale not hanging vertically or not set level; the indicator being too far away from the figures.

If correct, affix a gummed paper seal in a conspicuous place, or attach a wired lead seal to the frame.

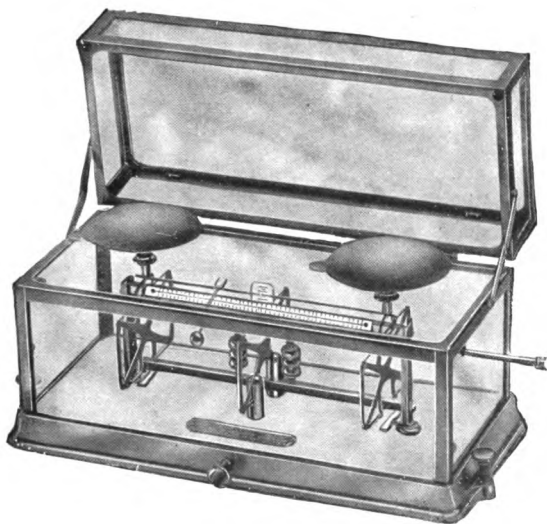
### SLOT WEIGHING SCALES

These are usually of the spring variety and are automatically set in motion by dropping a coin in the slot.

**Testing.** Place test weights up to the indicated capacity of the scale upon the platform and note the indicated readings on the dial. The pointer should stand at zero when unloaded and should not bind on either the card indicator or the glass cover. Move the weights to different parts of the platform and if inaccurate results are indicated, the scale should be tagged for repairs.

In most cases it is advisable for the sealer to have the agent or the owner of these scales with him while making the tests, as any needed adjustment can be made at once.

If correct, attach a gummed paper or wired lead seal in a conspicuous position on the scale.



### TORSION BALANCES

**Inspection.** Torsion balances make use of the torsion or twist of a wire or metallic band, substituting this for the knife edges in the ordinary type of scale. A balance is thus produced which is sensitive and very quick in its action.

**Testing.** If out of balance, adjust by raising or lowering the level of the scale by means of the leveling screws, or, if necessary, the pans may be unscrewed and additional lead shot placed in the shot cups. If any of the metallic bands are broken, the balance should be sent to the makers for repairs.

**Sealing.** If the balance is correct, it should be sealed by affixing a gummed paper seal, or attaching a wired lead seal to some rigid part.

## LIQUID CAPACITY MEASURES

Liquids are almost altogether sold by capacity, not by weight. If all measures of a certain denomination had a definite geometrical shape with a fixed ratio between the diameter and the height, the method of checking liquid measures would be very simple. But in trade, measures of various shapes occur, and the simplest test is to compare the measure directly with one of known capacity by the use of water.

Liquid measures may be divided, for convenience, into six classes.

1. Ordinary retail measures.
2. Milk measures.
3. Oil measures.
4. Hogsheads, barrels, etc.
5. Flasks.
6. Measuring pumps.

### ORDINARY LIQUID RETAIL MEASURES

**Inspection.** The measures should be strong enough to hold their shape and not be easily deformed or indented. Metal measures, other than aluminum or iron, should be thoroughly tinned or nickel plated, and earthenware vessels thoroughly glazed. Measures with flexible bottoms should not be allowed.

All measures should be pouring measures, that is, they should pour out the contents of the capacity indicated. An error commonly found in molasses and paint measures is that the commodity has so caked in the bottom or adhered to the sides that the quantity poured out is far short of what it should be.

**Testing.** The testing of liquid measures of large denominations should be done preferably at the sealer's office. The standard measure should be filled with water even with the top.

The fullness may be judged by the eye, or, better, by using a flat glass "slicker plate," with which the full measure is covered by sliding the plate over the top, care being taken that no bubbles form. The water should then be poured from the standard into the measure to be tested. Any water that may be left in the standard should be poured into a glass graduate (page 104), thus determining the deficiency, or if it takes more than the standard full, water should be poured from the graduate until the measure is full, and the amount that is necessary to fill the vessel noted. The amount lacking or in excess having been determined, the table of tolerance should be consulted (see page 149), and if the measure does not come within the allowable error it should be rejected. In no case should anything but water be used with a standard measure. If the measure is cylindrical, it may be tested with the gauge (see pages 120-121) or rule, by measuring the diameter and depth. Then, by using the tables on pages 165-191, etc., the calculated capacity is found. The table of tolerance on page 149 will show whether the measure should be sealed or not.

Measures larger than one gallon should be tested in a similar manner, using the large measures shown on page 119. It should always be noted carefully how full a store measure is usually filled. For instance, a five gallon can or a jar may hold the indicated capacity when it is full only to a certain mark and not to the brim.

**Sealing.** The measures which prove satisfactory after the inspection and test should be sealed. On metal measures the sealing clamp (see page 125) should be used or they should be placed over an iron sealing piece or stake (see page 125) and with a steel die (see page 122) stamped with the proper seal. If the measure is of glass, glazed earthenware or enameled ware it should be sealed with a lead seal (see page 128). If rejected, the measure should be marked or stamped "CONDEMNED."

### MILK MEASURES

**Inspection.** It is always advisable to have dairymen send their new bottles to the sealer's office before they are put into service. If sent from the manufacturer to the sealer it avoids unnecessary delay and future complications.

Milk measures in the form of ordinary measures should be inspected and tested according to the instructions given for inspection on page 57.

Milk bottles should be of clear glass, free from cracks or chips. Metal cans should have heavy bottoms, or better, they should be reinforced by metal strips. When provided with a faucet, it should be so arranged that the can may be emptied without unnecessary effort. All cans with a capacity of one gallon, or four liters or more, should be provided with handles.

**Testing.** The measures should be tested by the method described on page 57. All bottles should have a specified capacity when full to the bottom of the cap or stopper, in order that they may contain the requisite amount when full.

When many milk bottles have to be tested the comfort of working will be increased by using warm water instead of cold.

**Sealing.** Metal measures should be sealed according to the method described on page 57. Milk bottles should be stamped or marked with etching ink (see page 127.)

**Method of Using Etching Ink.** This ink should be kept and used in a dry place, as moisture will render it useless. Pour a very little on a lead pad (10231) adding enough of the thickening powder to make it of the consistency of marking ink. This will prevent the ink from spreading when placed on the milk jar. Use the rubber stamp

(page 127) in the same manner as with ordinary ink. The surface of the jar should be dry and free from grease. To remove grease, wash the outside of the jar with a strong solution of common washing soda. If the acid gets underneath the skin or finger nails, wash off immediately with water.

### OIL MEASURES

**Inspection.** Oil measures should be inspected according to the method described on page 57. When a spout or faucet is provided, it should be rigidly connected with the body of the measure and so placed that the measure is completely emptied without unnecessary effort. The bottom should be rigidly constructed and the larger measures reinforced with metal strips or bands.

When examining large oil tanks, the sealer should be careful to see that they are tight.

**Testing.** Small measures should be tested according to the method given on page 57. In testing large oil tanks for contents, or for a check on a measuring stick, it will be far more convenient to have an accurately tested and constructed five gallon or twenty liter bucket measure. (See page 119). This should be provided with a spout and be rigidly constructed, as the oil companies require that the tanks be very carefully tested before accepting a gauge rod for the particular tank in question.

**Sealing.** The measure, when satisfactory, should be sealed by stamping with a steel die or lead seal.

### HOGSHEADS, BARRELS, ETC.

**Inspection.** Hogsheads and barrels should be strongly made with the capacity and the net and tare weight burned or stamped into the head.

**Testing.** They may be tested by repeatedly filling from the largest size standard capacity measure, or by filling from a special tank of known capacity. Such a tank is

provided with a registering device, and a faucet from which the water flows into the cask. Or the test may be made by using a platform scale on which the barrel is weighed, first empty, clean and dry, and then filled with water. The difference will be the weight of the water contained. Divide this by 8.323, which is the weight of a gallon of water in lbs. and the result will be the number of gallons contained. For example: A barrel weighs 40 lbs. empty and  $302\frac{1}{4}$  lbs. when filled with water. Then  $302\frac{1}{4} - 40 = 262\frac{1}{4} \div 8.323 = 31\frac{1}{2}$ . Number of gallons contained,  $31\frac{1}{2}$ .

**Sealing.** A hogshead or barrel should be sealed by stamping or branding near the opening.

#### **GLASS GRADUATES, APOTHECARIES' MEASURES, ETC.**

**Inspection.** Glass graduates should be transparent and free from flaws or cracks. There should be no noticeable contraction where the graduations are made, and these should be clearly etched into the outside of the measure and never painted or otherwise affixed. The faucets should be of glass and ground or sealed into the vessel without the use of a foreign substance.

**Testing.** Such measures should be tested as indicated on page 57, but by using standard glass graduates (see page 104). In reading the surface of the liquid measure, it should be held in such a manner that the surface is horizontal and the graduation mark even with the surface of the water.

For small measures or graduates, burettes with glass stop cocks should be used. (See page 105.) The burette should be placed in its holder (see page 105), filled with distilled water, the stop-cock opened and a drop or two allowed to flow out. The reading of the water level in the burette should then be taken, after which the graduate to be tested should be placed under the cock and water allowed to flow into it slowly, until the water level is exactly even with the graduations. The water surface in the burette

should be read and from these readings the exact amount of water allowed to flow into the measure is found. This should correspond with the capacity value etched on the measure under test.

**Sealing.** The measure or graduate which is found satisfactory should be sealed with etching ink, immediately above the uppermost graduation.

### MEASURING PUMPS

**Testing.** These should be tested in the manner in which they are used. Place the testing measure underneath the faucet, set the proper stop and turn the handle as far as it will revolve. Each stop should be tested at three speeds, fast, slow and medium.

In one type of pump, adjustment is made by loosening the nut at the top of the rack with a wrench, and raising or lowering the rack as required. On this pump, the alteration of the 1 gallon stop will change all other stops, and for that reason, the gallon should be made the first test. The stops for the smaller measures may be adjusted by loosening the set nuts and raising or lowering the stops on the vertical rod as needed. On another variety of pump, each stop is independently adjusted on the threaded vertical rod. Be sure that all nuts, stops, etc., are securely fastened before sealing.

If the pump gives varying results after adjusting, it should be repaired, as the valves or washers are probably worn out. A cheap set of measures should be procured for these tests, as nothing but clean water should be used in the standards.

**Sealing.** If correct, place wired lead seals through the holes in each stop or place caps, which are provided for this purpose by the manufacturers of some pumps, over the stop nuts and secure these with lead seals.

## DRY CAPACITY MEASURES

Dry capacity measures may be divided in the following classes :

1. Ordinary store measures.
2. Berry or fruit boxes and baskets.
3. Barrels and crates.
4. Baskets and bags.
5. Bins and carts.

### ORDINARY STORE MEASURES

**Inspection.** A dry measure may be of wood, metal, or composition, but it must be strong enough to withstand ordinary usage and should not show any deformation. If of metal, except steel, the bottom and sides should be reinforced. Bottomless measures should not be allowed.

Particular attention should be paid to the appearance of the measure.

A wooden measure may have a false bottom inserted, or have the bottom reduced in size and the sides lapped. The latter case is always evident, because the machine nailing has been taken out and the lap imperfectly made. Many measures are sawed off at an angle, being deeper on one side than on the other. Many false measures are found with loose bottoms.

Metal measures are sometimes indented or provided with a raised bottom. Liquid capacity measures are sometimes used in place of dry capacity measures. When any evidence of fraud exists, the measures should be examined with special care.

Dry measures should always be striking measures, that is, when filled flush with the upper edge, they should have the required capacity.

**Testing.** If the measure is cylindrical in shape, its capacity may be obtained by measuring its depth and diam-

cter by means of the Gurley dry measure gauge (10069, see page 120). When using this gauge, the figures representing the depth and diameter of the measure under test are added together, and the results should be as follows:

1 bushel = 100

$\frac{1}{2}$  bushel = 90

1 peck = 80

$\frac{1}{2}$  peck = 70

2 quarts = 60

1 quart = 50

1 pint = 40

$\frac{1}{2}$  pint = 30

$\frac{1}{4}$  pint = 20

If the sum of the depth and diameter does not come within the maximum and minimum table on page 149, which represents the tolerance in cubic inches, the measure should be condemned and confiscated.

Or by measuring the depth and diameter with an ordinary rule, the capacity may be found by referring to the tables on pages 165–193. If the diameter or depth is greater than that given in the table, the capacity may be calculated by multiplying 3.1416 by the square of the diameter (diameter multiplied by itself) dividing this by 4 and multiplying the result by the depth. The product will be the number of cubic inches contained in the measure.

Metal measures may be tested by using the method described on page 57.

Probably the best method of testing dry measures is by making use of a hopper funnel (page 117). Measures which do not hold water, such as wooden dry measures, baskets, boxes or bags, can be accurately tested with this device, using flaxseed, wheat or small beans. The instrument should be set on a bench or platform where there is the least vibration. Place the standard measure under the hopper and pour enough flaxseed into the hopper to overflow the measure. Open the slide and allow all the flax-

seed to flow into the standard. Strike it off roughly, using a round striking stick (10075) for this purpose. This striking stick should be swept, not rolled across the measure. Close the slide and empty the standard into the funnel. Repeat the operation and strike off carefully. Again empty the standard into the funnel and remove the excess grain from the base board or pan.

Place the measure to be tested under the funnel and allow the grain to flow into it. Strike off carefully and measure the overflow, if any, using a glass graduate divided into cubic inches (page 105). If the measure is large, add a known quantity of grain, more than enough to fill the measure, and deduct the amount of overflow, which will give the true error.

As the amount of grain a measure will hold varies, depending on the height from which it is dropped, the position of the funnel should not be changed during a test.

**Sealing.** If the measure is correct it should be stamped on the upper rim across the lap, and on the bottom inside and outside, or by burning on the side across the lap with a branding iron.

### BERRY OR FRUIT BOXES AND BASKETS

**Inspection.** Berry or fruit boxes are often made with a false bottom or with the sides and bottoms curved inward. They should be inspected for evidence of fraud.

**Testing.** A small dry capacity measure standard (see page 116), or a berry measure (see page 118), should be filled with small fruit or coarse grain, which should then be poured into the box or basket to be tested. If there is a shortage, the box or basket should be rejected. There is more fraud practised in connection with berry boxes than with almost any other form of dry measure.

To find the capacity of the ordinary berry box with sloping sides by measurement, add together the area of the top and bottom, multiply by the depth and divide by 2. Example: A berry box is 5.1 inches square on top, 4.3

inches square on the bottom and 3 inches in depth; then  $(5.1 \times 5.1) + (4.3 \times 4.3) \times 3 \div 2 = 66.7$  cubic inches.

**Sealing.** It is not necessary to seal berry boxes, as they are used but once, but the deficient boxes should be confiscated and the offenders punished.

### BARRELS AND CRATES

**Inspection.** Barrels and crates should be strong enough to withstand ordinary handling by carrier companies.

**Testing.** The laws of some states specify the legal dimensions of many barrels and crates. If this is not specified, the cubic contents can be found for barrels by measuring the mean diameter and depth, using the method on page 63, and for crates by the method on page 66.

**Sealing.** Barrels and crates may be sealed by burning with a branding iron (page 126) or marking with a stencil (page 129).

### BASKETS AND BAGS

**Inspection.** Baskets should be strong and rigid enough so that there is no appreciable deformation when they are filled or lifted.

**Testing.** If a basket is of a regular shape, the capacity may be found by measurement and calculation. If smaller at the bottom than the top, the average area of the bottom, middle and top diameters should be taken and the cubic contents calculated by the method on page 64. If irregular in shape, it may be tested by using a hopper funnel (page 117).

Bags are frequently used in retailing charcoal, etc. The capacity of the bag should be clearly marked on the outside, together with the dealer's name. When the sealer is suspicious that bags are undersized, he should measure them, allowing 6 inches at the top for tying, and comparing the measurements with those of a bag found by test to contain the required amount.

**Sealing.** Baskets should be sealed by stamping or burning the rim. Bags of deficient capacity should be seized.

### **BINS**

The capacity of bins or boxes is found by multiplying the number of inches in the depth, length and width together and the result will be the number of cubic inches contained. Divide this by 2150.42 if the capacity in bushels is desired. If the number of pounds of coal is required, multiply the number of cubic feet in the bin by 58.1 if anthracite and 52.5 if bituminous, these being the average number of pounds in a cubic foot. Coal will vary in weight according to its density, but the latter rule is accurate enough for all practical purposes, as anthracite coal will average 34.4 cubic feet and bituminous 38.1 cubic feet to the ton of 2000 lbs.



## LENGTH STANDARDS

Our primary linear standards have been certified by the highest authority in the world, the International Bureau of Standards of Sevres, France. This bureau is the court of last resort on all matters pertaining to weights and measures. Every intermediate division of these standards has been certified and all of the linear standards made by us are referred to these. Comparisons are made on a comparator of exceptionally heavy construction and in a constant temperature room; thereby the highest degree of accuracy is obtained.

### YARD STANDARD

**No. 9000.** This measure is made of ribbed bronze, combining lightness and rigidity. It is divided on one edge of the face for thirty-seven inches into thirty-seconds of an inch. It has a fixed stop at the zero end and another half way across the face of the bar at the thirty-six-inch mark. The measure is accurately divided and highly finished.

Price in wooden case, . . . . . \$20.00

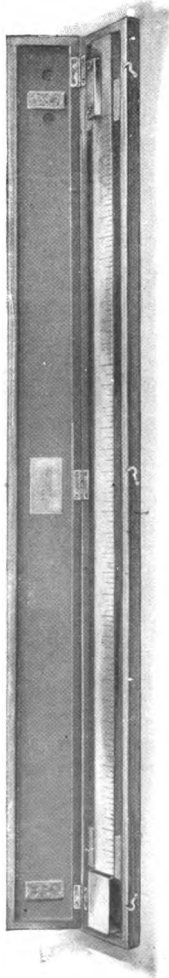
### METER STANDARD

**No. 9001.** Similiar to No. 9000, but divided for one hundred and one centimeters into millimeters. Price in wooden case, \$20.00

### METER AND YARD STANDARD

**No. 9002.** Similar to No. 9000, but divided into sixteenths of an inch on one edge and millimeters on the other.

Price in wooden case, . . . . . \$25.00



9000

**YARD STANDARD**

**No. 9003.** Flat pattern, divided to thirty seconds of an inch on a silver strip inlaid in bronze.

Price in case, . . . . . \$40.00

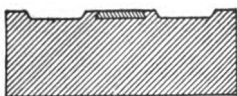
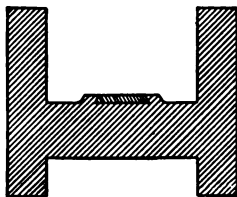
**METER STANDARD**

**No. 9004.** Flat pattern, similar to No. 9003.

Price in case, . . . . . \$40.00

**YARD STANDARD**

**No. 9005.** This measure is divided into thirty-seconds of an inch on a silver strip inlaid in bronze. The section is in the form of an H, and is similar to that used by the

**9004****9005**

International Bureau of Standards. This section gives the maximum strength and surface with minimum mass. The divisions are made along the neutral axis where they are little affected by flexure. Price, including case, . \$60.00

**METER STANDARD**

**No. 9006.** Similar to No. 9005. Price, . . . \$60.00

**No. 9010.** Vernier to be used in connection with Nos. 9000-9002. Price, . . . . . \$5.00

*We are prepared to furnish to order standard linear measures of nickel steel, which has a zero temperature coefficient of expansion, thus having an invariable length when the temperature is within ordinary range.*

Prices on application.

**YARD STANDARD**

**No. 9012.** This yard standard is made of nickel plated steel with bronze stops for inside and outside measurements. It is divided in inches and in fractions of a yard, the last inch being divided to thirty-seconds of an inch. Sealers find it very convenient as a gauge to rapidly and accurately test yard sticks.

The primary features that recommend this standard to sealers are convenience, accuracy, permanency, and *lightness*.

Price, . . . . . \$12.00

**METER STANDARD**

**No. 9013.** Similar to No. 9012, but divided into centimeters, the last centimeter to millimeters.

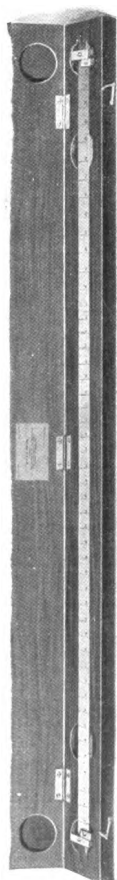
Price, . . . . . \$12.00

**WOODEN YARD STANDARD**

**No. 9015.** This sealer's yard standard is made of carefully dried hard wood, one square inch in section, brass bound on the ends, provided with a stop and graduated for thirty-six inches into sixteenths of an inch. The fractional parts of a yard are graduated on the side. The standard is engine divided and tested. This is a most convenient and light working standard.

Price, . . . . . \$3.00

Canvas case . . . . . .50

**9012**

**LINE MEASURE COMPARATOR OF ONE METER RANGE**

**No. 9018.** The heavy iron base on leveling screws has scraped ways its entire length. On these slide two microscopes provided with a transverse motion. One of the microscopes is mounted on a micrometer slide; the other is fitted with a filar micrometer eyepiece. The scales to be compared are laid on two bars, each independently adjustable in all directions. The bars are mounted on a roller slide which may be rapidly or slowly moved across the base, thus bringing either of the scales in the field of the microscopes. Linear scales up to one meter in length may be compared.

Price on application.

**BENCH STANDARDS OF LENGTH**

Every State Sealer and the Sealers of large communities should have, as part of their equipment, a standard length measure with which to compare long rods or tapes. We are prepared to make these, the price depending on the form and nature of the bar, on the method and style of mounting, and also on any accessories which may be desired.

Prices on application.

**TAPE STRETCHING DEVICES**

We are prepared to furnish a steel tape testing device consisting of plates to be set in the floor at intervals, into which can be screwed a clamp and tension device. The standard tape and the tape under test are secured side by side in the clamp, the proper tension applied by means of a screw and the points of coincidence noted. Price and specifications upon application.

**MICROMETER MICROSCOPES**

Micrometer microscope attachments to bench standards.  
Prices on application.

## TAPES

### STEEL TAPES

The sealer will have frequent use for a standard steel tape for testing tapes and chains or in making long measurements.

These tapes are specially made for this purpose, the zero graduation being on the tape and not at the ring.

No.	Make	Length	Width	Case	Price
9123	Star	25 ft.	$\frac{3}{8}$ in.	Nickeled Brass	\$3.00
9124	"	50 "	"	"	3.00
9125	"	100 "	"	"	6.40
9131	Reliable	50 "	$\frac{1}{2}$ in.	Brass Frame with Handle	7.50
9132	"	100 "	"	"	13.50
9133	"	15 meters	"	"	7.50
9134	"	30 "	"	"	13.50

### POCKET STEEL TAPES IN NICKELED CASE

DIVIDED TO 10THS OR 12THS			DIVIDED TO 10THS OR 12THS AND METRIC		
No.	Length	Price	No.	Length	Price
9150	3 ft	\$0.80	9153	3 ft.	\$0.85
9151	6 "	1.00	9154	6 "	1.25
9152	12 "	2.40	9155	12 "	2.50

### STEEL TAPE FOR TESTING YARD MEASURES

This small vest pocket tape is 6 feet long, divided on one side into feet, inches and 16ths, the other side being divided into yards and fractions of yards. It is contained in a small nickel plated case. Sealers will find this tape convenient, and easy to carry.

No. 9156, Price . . . . . \$1.40

### PUNCH AND SET FOR REPAIRING TAPE LINES

No.	Price
9160 Punch and Riveter with Eyelets . . . . .	\$5.00
9161 Eyelets (two lengths), 500 of each length . . . . .	1.25

**STEEL SCALES, STANDARD QUALITY****9062****METRIC AND ENGLISH MEASURES**

These scales have the first edge divided to 1 mm.; the second to .5 mm., the third to .01 of an inch, the fourth to 1/64 of an inch.

No.	Length	Price	No.	Length	Price
9060	10 centimeters	\$0.45	9063	30 centimeters	\$1.25
9061	15       "	.65	9064	50       "	2.00
9062	20       "	.85	9065	100       "	7.00

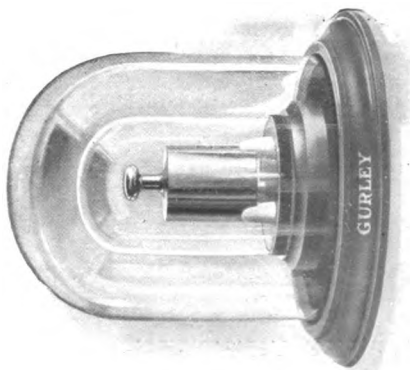
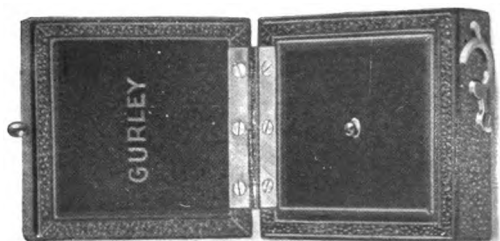
**MASTER SLIDE RULE**

This three-foot boxwood rule will be found very convenient for determining the inside measurement of boxes, baskets and barrels having diameters of eight inches or over. The slides can be extended inside the article to be measured and the dimension will be shown in inches and sixteenths.

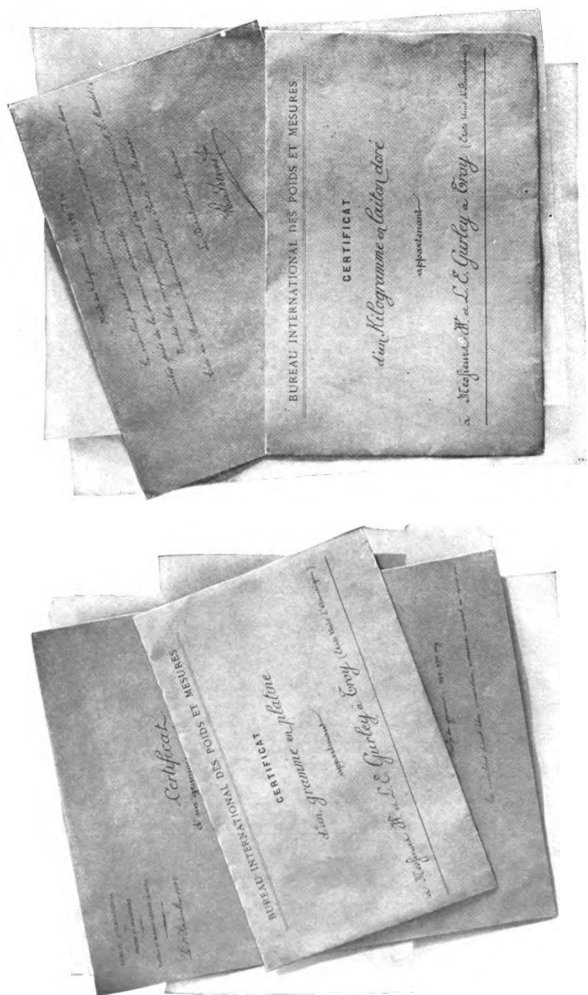
No. 9162, Price . . . . . \$0.45

**BOXWOOD RULES**

No.		Price
9165	Boxwood Rule, two feet, four fold, brass edges, bound, 8ths and 16ths of inches.....	\$0.35
9166	Boxwood Rule, two feet, four fold, 8ths and 16ths of inches.....	.15
9167	Flexible Wood Rule, four feet, eight fold, divided to millimeters and 16ths of inches, spring joints.....	.50
9168	Flexible Wood Rule, same as No. 9167, and with white enamel finish.....	.60



The Above Illustration Represents our Primary Standards of Weight, the Kilogram and Gram, to which our Working Standards are Referred. These have been Verified by the International Bureau of Weights and Measures at Sevrès, France, and by the National Bureau of Standards at Washington, D. C.



Certificates for the Standard Kilogram and Standard Gram Illustrated on Preceding Page

## WEIGHTS



9213

### **GOLD PLATED PRECISION WEIGHTS**

#### **NATIONAL BUREAU OF STANDARDS DESIGN**

The weights on pages 77 to 80 are adjusted and constructed to conform to National Bureau of Standards specifications (see pages 152-153), and will be sent to that Bureau for test if desired. The cost of this verification, when there is any, is to be borne by the purchaser.

The weights down to one gram are made of one piece of Tobin bronze, carefully adjusted by means of the gold plating. They are the highest type of precision weight, as they are made of one piece with no loose parts, and are unaffected by salts or acids. Each set is contained in a velvet lined case, the platinum weights 500 mg. and below being covered by a glass bar. The prices include weight forks and ivory tipped pincettes.

In all sets of weight of this type, the total is twice that of the initial weight.

### METRIC WEIGHTS

No.	Range	No. of Weights	Price
9170	20 kilogram to 1 kilogram	6	\$255.00
9173	20 " 1 gram	18	308.00
9174	10 " 1 "	17	208.00
9175	5 " 1 "	16	148.00
9176	1 " 1 "	13	73.00
9177	500 grams to 1 m. g.	25	73.00
9179	100 " 1 "	22	52.00
9180	50 " 1 "	21	46.00
9181	20 " 1 "	19	36.50
9183	10 " 1 "	18	31.50

NOTE.—If platinum weights of 5/10, 2/10, 2/10, 1/10 milligrams in addition are desired, add \$2.00 to the list prices for the set of four additional weights.

Single weights similar to the preceding as follows:

No.	Weight	Price	No.	Weight	Price
9190	20 kilograms	\$100.00	9198	200 grams	\$7.00
9191	10 "	60.00	9199	100 "	6.00
9192	5 "	45.00	9200	50 "	5.50
9193	4 "	36.00	9201	20 "	5.00
9194	3 "	28.00	9203	10 "	4.00
9195	2 "	20.00	9204	5 "	4.00
9196	1 "	10.00	9205	2 "	4.50
9197	500 grams	8.00	9206	1 gram	4.50

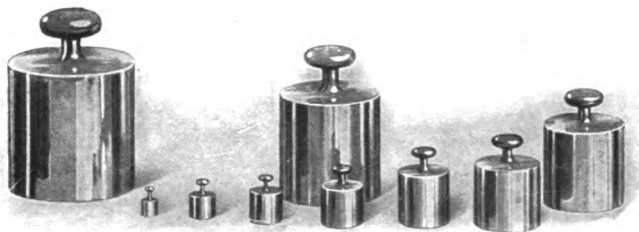
### FRACTIONAL GRAM WEIGHTS OF PLATINUM

Contained in a glass covered case with pincettes.

No.		Price
9260	Set of weights, from 500 milligrams to 1 milligram (13 pieces).....	\$15.00
9261	Set of weights, from 500 milligrams to $\frac{1}{10}$ milligram (17 pieces).....	18.00

Single weights similar to the preceding as follows:

No.	Weight	Price	No.	Weight	Price
9266	500 milligrams	\$3.00	9272	5 milligrams	\$1.00
9267	200 "	2.00	9273	2 "	1.00
9268	100 "	1.50	9274	1 milligram	1.00
9269	50 "	1.25	9275	$\frac{5}{10}$ "	1.00
9270	20 "	1.00	9276	$\frac{2}{10}$ "	1.00
9271	10 "	.75	9277	$\frac{1}{10}$ "	1.00



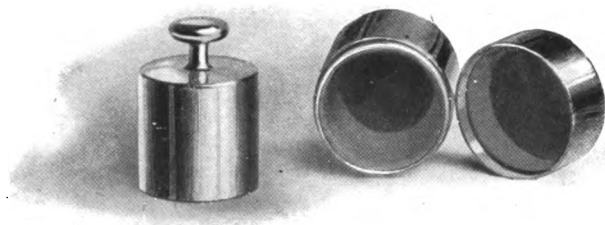
### AVOIRDUPOIS WEIGHTS

These weights are of the same construction and accuracy as those described on page 76. They are contained in a velvet lined case with weight forks and ivory tipped pincettes.

No.	Range	No. of Weights	Price
9210	50 lb. to 1 lb.	8	\$298.00
9213	50 " $\frac{1}{16}$ oz.	17	340.50
9214	25 " $\frac{1}{16}$ "	16	225.50
9215	10 " $\frac{1}{16}$ "	14	135.50
9216	4 " $\frac{1}{16}$ "	12	77.50
9217	1 " $\frac{1}{16}$ "	10	52.50

Single weights similar to the preceding as follows:

No.	Weight	Price	No.	Weight	Price
9220	50 lb.	\$100.00	9229	8 oz.	\$7.00
9221	25 "	70.00	9230	4 "	6.00
9222	20 "	60.00	9231	2 "	5.50
9223	10 "	45.00	9232	1 "	5.00
9224	5 "	20.00	9233	$\frac{1}{2}$ "	4.00
9225	4 "	15.00	9234	$\frac{1}{4}$ "	4.00
9226	3 "	12.00	9235	$\frac{1}{8}$ "	4.00
9227	2 "	10.00	9236	$\frac{1}{16}$ "	4.50
9228	1 "	8.00	9237	$\frac{1}{32}$ "	4.50

**9238 and Case**

**No. 9238.** A one piece, one pound gold-plated precision weight in felt lined brass case. Price, . . . . \$9.50

### GRAIN WEIGHTS

These weights are of the same construction and accuracy as described on page 76, the weights less than 20 grains being made of platinum. They are contained in a velvet lined case with weight forks and ivory tipped pincettes, the flat weights being covered with a glass bar.

No.	Range		No. of Weights	Price
9241	10000 grains to	$\frac{1}{10}$ grain	21	\$72.00
9243	5000	" $\frac{1}{10}$ "	20	60.00
9246	1000	" $\frac{1}{10}$ "	17	40.00
9247	1000	" $\frac{1}{100}$ "	21	41.00
9248	1000	" $\frac{1}{1000}$ "	25	43.00
9249	100	" $\frac{1}{10}$ "	13	21.50
9250	100	" $\frac{1}{100}$ "	17	22.50
9251	10	" $\frac{1}{10}$ "	9	12.00
9252	100	" $\frac{1}{1000}$ "	21	24.50
9255	10	" $\frac{1}{100}$ "	13	13.00
9256	10	" $\frac{1}{1000}$ "	17	15.00

Prices for single weights from the above sets given on application.



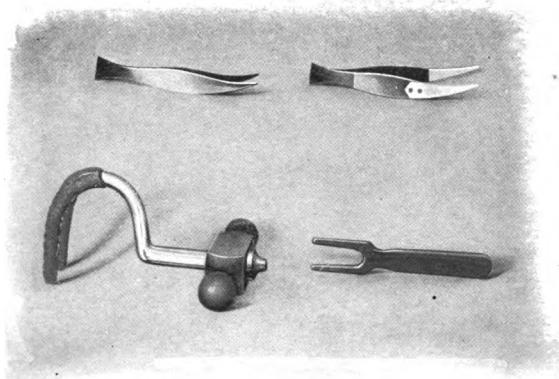
9290

**TROY WEIGHTS**

These weights are of the same construction and accuracy as those described on page 76. They are contained in a velvet case with weight forks and ivory tipped pin-cettes. When these sets are desired containing weights less than one pennyweight, they may be combined with Nos. 9251, 9255, 9256.

No.	Range	No. of Weights	Price
9280	One 500 oz. to 1 dwt.	17	\$300.00
9282	" 200 " 1 "	16	200.00
9284	" 100 " 1 "	14	115.00
9285	" 50 " 1 "	13	85.00
9290	" 10 " 1 "	10	51.00
9291	" 5 " 1 "	9	43.00
9294	" 1 " 1 "	6	26.00

Prices for single weights similar to those in the preceding sets given on application.



8992  
8994

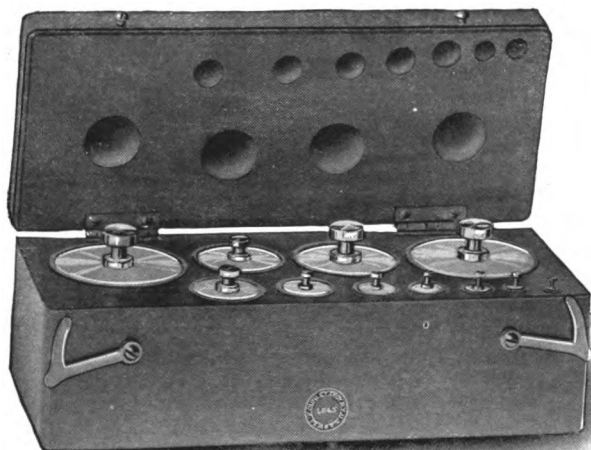
8990  
8996

### PINCETTES AND WEIGHT HOOKS

No.		Price
8990	Ivory tipped brass pincettes for weights, each .....	\$0.75
8992	Brass pincettes for weights, each.....	.25
8994	Brass weight hook, chamois covered, mahogany handle, each.....	1.50
8995	Brass weight hook, chamois covered, heavy construction, brass handle, each.....	3.50
8996	Hardwood weight fork, each.....	.30

### BRASS TEST WEIGHTS

These brass screw knob weights (pages 82 to 86), are highly finished and lacquered, and have the denomination engraved on the knob. They are used by the Sealer in connection with the portable balance, for scale testing, or in any case where an accurate set of weights is desired. Adjustment is made to the degree of precision and according to the specifications required by the National Bureau of Standards (see pages 152-153) and must not be confounded with the lead filled brass cased weights often used. Attention is called to the fact that



### 9305

the knobs of these weights are screwed in and not plugged or pinned. This method of construction allows the sealer to easily readjust them. The weights are finished all around and on the bottoms. The sets are fitted in polished velvet lined cases with cover.

If brass weights are desired with nickel plated finish, a charge of 15 per cent in addition to the list prices will be made; if gold plated finish is required, a charge of 20 per cent.

### AVOIRDUPOIS WEIGHTS

No.	Range	No. of Weights	Price
9297	50 lb. to 1 lb.	8	\$95.25
9300	50 " $\frac{1}{16}$ oz.	16	102.55
9301	25 " $\frac{1}{16}$ "	15	65.00
9302	10 " $\frac{1}{16}$ "	13	36.00
9303	4 " $\frac{1}{16}$ "	11	15.00
9304	1 " $\frac{1}{16}$ "	9	10.50
9305	Two 2 " $\frac{1}{16}$ "	11	14.50

Single weights similar to the preceding:

No.	Weight	Price	No.	Weight	Price
9307	50 lb.	\$35.00	9316	8 oz.	\$2.00
9308	25 "	24.00	9317	4 "	1.50
9309	20 "	22.00	9318	2 "	1.25
9310	10 "	15.00	9319	1 "	1.00
9311	5 "	6.50	9320	$\frac{1}{2}$ "	.50
9312	4 "	4.00	9321	$\frac{1}{4}$ "	.40
9313	3 "	3.50	9322	$\frac{1}{8}$ "	.40
9314	2 "	3.00	9323	$\frac{1}{16}$ "	.50
9315	1 "	2.25	9324	$\frac{1}{32}$ "	.50

### METRIC WEIGHTS

These weights are of the same construction and accuracy as those described on page 82, the weights below one gram being made of aluminum. Each set is contained in a velvet lined case, the aluminum weights being covered with a glass bar.

No.	Range	No. of Weights	Price
9325	20 kilograms to 1 kilogram	6	\$84.00
9328	20 " 1 gram	18	95.00
9329	10 " 1 "	17	60.00
9330	5 " 1 "	16	39.00
9331	1 " 1 "	13	14.00
9332	500 grams to 1 m. g.	25	14.25
9334	100 " 1 "	22	8.25
9335	50 " 1 "	21	6.50
9336	20 " 1 "	19	5.75
9338	10 " 1 "	18	5.25

NOTE.—If aluminum weights of 5/10, 2/10, 2/10, 1/10 milligrams in addition to the above sets are desired, add 75 cents to the list price for the set of four additional weights. Prices of single weights similar to the above will be given upon application.

### GRAIN WEIGHTS

These weights are of the same construction and accuracy as those described on page 82, the weights less than 20 grains being made of aluminum. They are contained in a velvet lined case with pincettes, the flat weights being covered with a glass bar.

No.	Range		Number of Weights	Price
9361	10000 grains to	$\frac{1}{10}$ grain	21	\$19.00
9363	5000	" $\frac{1}{10}$ "	20	15.00
9366	1000	" $\frac{1}{10}$ "	17	9.50
9367	1000	" $\frac{1}{100}$ "	21	10.00
9368	1000	" $\frac{1}{1000}$ "	25	10.50
9369	100	" $\frac{1}{10}$ "	13	7.00
9370	100	" $\frac{1}{100}$ "	17	7.50
9371	100	" $\frac{1}{1000}$ "	21	8.00
9372	10	" $\frac{1}{10}$ "	9	3.00
9373	10	" $\frac{1}{100}$ "	13	3.50
9374	10	" $\frac{1}{1000}$ "	17	4.00
9378	This set will be found useful in determining the error on weights, the sensitiveness of balances, etc., below $\frac{1}{16}$ oz. Consists of aluminum weights, 20, 10, 5, 2, 2, 1 grains in small covered box.....			\$1.75

Prices of single weights from the sets listed above on application.

### TROY WEIGHTS

These weights are of the same construction and accuracy as those described on page 82, and are contained in a velvet lined case. When these sets are desired containing weights less than one pennyweight, they may be combined with Nos. 9251, 9255, 9256, 9372, 9373, 9374.

No.	Range	No. of Weights	Price
9380	One 500 oz. to 1 dwt.	17	\$81.00
9382	" 200 " 1 "	16	43.50
9384	" 100 " 1 "	14	25.50
9385	" 50 " 1 "	13	17.75
9389	" 10 " 1 "	10	12.00
9390	" 5 " 1 "	9	9.50
9393	" 1 " 1 "	6	5.50

Prices of single weights from the sets listed will be given on application.

**APOTHECARIES' WEIGHTS**

This set is necessary when testing prescription weights. It consists of weights 12, 6, 2, 2, 1 oz., 4, 2, 1 drachms, 2, 1 scruples, 10, 5, 2, 1, 1,  $\frac{5}{10}$ ,  $\frac{2}{10}$ ,  $\frac{2}{10}$ ,  $\frac{1}{10}$  grains, in velvet lined case with pincettes. The flat weights are covered with a glass bar. This set can also be used for testing Troy weights.

**No. 9394.** Made of one piece of Tobin bronze, accurately adjusted by means of the gold plating to National Bureau of Standards specifications. (See pages 152-153.) The weights less than 20 grains are made of platinum.

Price . . . . . \$60.00

**No. 9395.** Same as 9394, but with brass screw knob weights. The weights less than 20 grains are made of aluminum.

Price . . . . . \$18.00

**ASSAY TON WEIGHTS**

The assay ton weights were introduced by Prof. C. F. Chandler, of the School of Mines, Columbia College, New York, where they are now used for convenience in the assay of ores. The weight denominated by Dr. Chandler as "One A. T." equals 29.1666 grams, and contains consequently as many milligrams as there are Troy ounces in a ton avoirdupois of 2000 pounds. Therefore, if one A. T. of ore assays one milligram, the ton contains one Troy ounce.

No.		Price
9396	Assay ton weights, constructed of one piece of Tobin bronze, carefully adjusted by means of gold plating. They are non-oxidizable and conform to National Bureau of Standards specifications (see pages 152, 153). Contained in a velvet lined case, with pincettes. Set consists of 4, 2, 1, $\frac{1}{10}$ , $\frac{1}{10}$ , $\frac{1}{10}$ , $\frac{1}{10}$ A. T. . . . .	\$32.00
9397	Same as 9396, but with brass, screw knob weights, N. B. S. specifications. . . . .	8.00

**CUP WEIGHTS****9400**

These nested cup weights form a very compact and convenient set for traveling inspectors. They are accurately adjusted and are made of solid bronze, the outside being polished.

No.		Price
9400	Avoirdupois nested cup weights from 4 lbs. to $\frac{1}{4}$ oz. .	\$12.50
9403	Troy nested cup weights from 64 oz. to $\frac{1}{4}$ oz. ....	12.50
9402	Hand-sewed sole leather carrying case with hinged cover for the above .....	2.50

**KARAT WEIGHTS**

This set will be found necessary by the sealer when testing weights used by dealers in precious stones. Contained in velvet lined case with pincettes, the smaller weights being covered with a glass bar.

**No. 9410.** Consists of weights 100 karats to  $\frac{1}{64}$  karat (16 weights) made of one piece of Tobin bronze accurately adjusted by means of the gold plating to conform to National Bureau of Standards specifications. The weights below 5 karats are made of platinum.

**No.**  
**9411** Same as 9410 but with brass screw knob weights. The weights below 5 karats are made of aluminum.  
 Price of the above sets upon application.

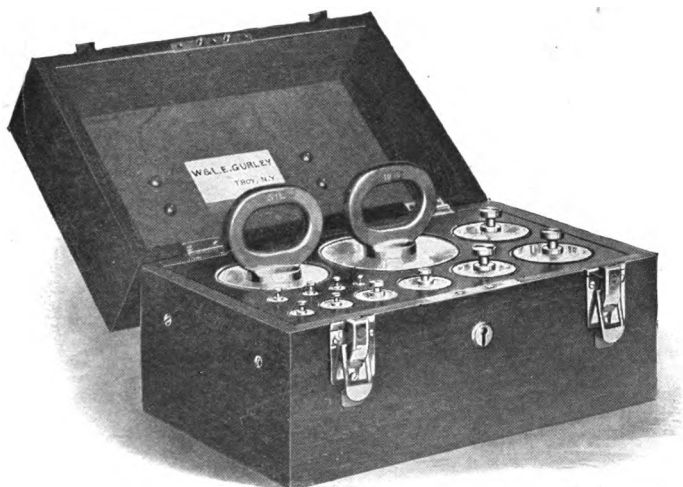
**FRACTIONAL ALUMINUM GRAM WEIGHTS**

Contained in a glass covered case with pincettes.

No.		Price
9484	Set of weights from 500 milligrams to 1 milligram (13 pieces) .....	\$2.25
9485	Set of weights from 500 milligrams to $\frac{1}{16}$ milligram (17 pieces) .....	3.00

Single weights similar to the preceding:

No.	Weight	Price	No.	Weight	Price
9487	500 milligrams	\$0.30	9493	5 milligrams	\$0.10
9488	200 "	.25	9494	2 "	.10
9489	100 "	.20	9495	1 "	.10
9490	50 "	.15	9496	$\frac{5}{16}$ "	.30
9491	20 "	.15	9497	$\frac{1}{16}$ "	.30
9492	10 "	.10	9498	$\frac{1}{16}$ "	.30



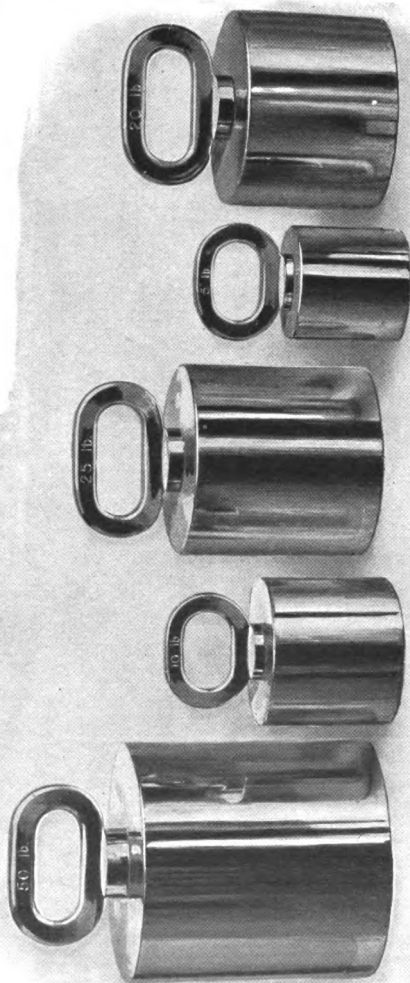
9399

**NICKEL PLATED AVOIRDUPOIS WEIGHTS**

**No. 9399.** This set contains nickel plated weights from 10 lbs. to 1/16 oz. (13 weights) carefully fitted in a velvet lined mahogany case, with handle, lock and catches. As the total amount of weights is approximately 21 lbs., this set will be found sufficient to test the ordinary counter and spring scales. The five and ten-lb. weights are provided with grip handles. It is compact, convenient and easily carried.

This set is also convenient for the use of merchants who wish to have accurate as well as handsome test weights with which to compare their own scales and weights. When desired, weights may be sent to the National Bureau of Standards or to any State Department of Weights and Measures for verification and stamping, the cost for which, when there is any, being borne by the purchaser.

Price . . . . . \$25.00



9420

**STEEL TEST GRIP WEIGHTS**

These bright nickel plated weights are made of selected cold rolled steel with a grip handle screwed in. They are very convenient and practical test weights, especially for secondary standards to be carried by the sealer.

Adjustment is made to the degree of precision required by the National Bureau of Standards.

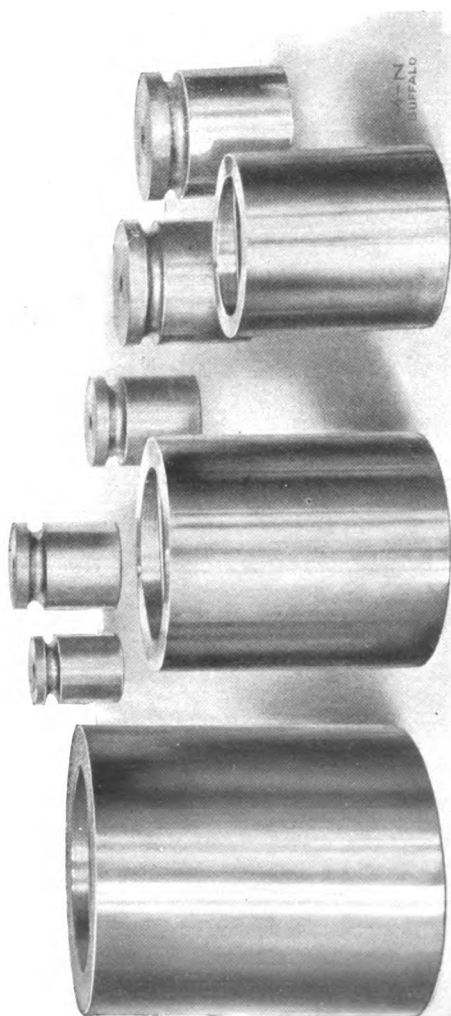
No.		Price
9419	Set of avoirdupois weights as follows: 25, 10, 5 lb.....	\$12.25
9420	Set of avoirdupois weights as follows: 50, 25, 20, 10, 5 lb.....	30.00
9421	Set of avoirdupois weights as follows: 50, 20, 10, 10, 5, 2, 2, 1 lb.....	35.00
9422	Set of metric weights as follows: 20, 10, 5, 2, 2, 1 kg....	32.00
9423	" " " " " " " 20, 10, 5 kg.....	24.00
9424	Set of Troy weights as follows: 500, 200, 100, 100, 50oz.	26.00
9425	" " " " " " " 500, 200, 100, 100, 50, 20, 20, 10 oz.....	30.00

Single weights similar to the above:

No.	Weight	Price	No.	Weight	Price
9428	50 lb.	\$15.00	9442	2 kilograms	\$3.00
9429	25 "	6.00	9443	1 kilogram	2.25
9430	20 "	5.75	9444	500 oz. Troy	12.00
9431	10 "	3.50	9445	300 " "	5.75
9432	5 "	3.00	9446	200 " "	4.50
9435	2 "	2.00	9447	100 " "	3.50
9436	1 "	1.50	9448	50 " "	2.75
9437	20 kilograms	15.00	9449	40 " "	2.75
9438	10 "	6.00	9450	30 " "	2.25
9439	5 "	4.00	9451	20 " "	2.00
9440	4 "	3.50	9452	10 " "	1.00
9441	3 "	3.25			

**STEEL TEST WEIGHTS****NATIONAL BUREAU OF STANDARDS DESIGN**

These nickel plated test weights are made of selected steel, carefully turned. The top is cupped, with the handle passing through the cup. As there are no projecting parts, the weights may be easily stacked. The adjustment is made by means of a brass plug which is driven into the



9453

adjusting hole and the seal affixed. The distinctive feature of these weights is that there are no screwed parts, and after once being sealed they cannot be altered without seriously marring the outside or destroying the seal. These weights are made according to the latest designs and specifications of the National Bureau of Standards and are accurately adjusted in conformity with their requirements.

No.		Price
9453	Avoirdupois set as follows: 50, 25, 10, 5, 5, 2, 2, 1 lb...	\$55.00
9454	Metric set as follows: 20, 10, 5, 2, 2, 1 kg.....	42.00
9455	Troy set as follows: 500, 200, 100, 100, 50, 20, 20, 10 oz..	55.00

Single weights similar to the above, prices on application.

### IRON TEST WEIGHTS

#### NATIONAL BUREAU OF STANDARDS FORM

These weights are of the same form and method of adjustment as those described on page 89, but are made of cast iron with steel handles. They are finished with two coats of japan lacquer baked on.

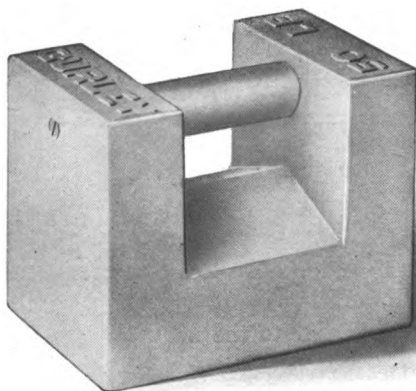
No.		Price
9510	Set as follows: 50, 25, 10, 5, 5, 2, 2, 1 lb.....	\$30.00
9511	Set as follows: 20, 10, 5, 2, 2, 1 kg.....	26.00

Single weights, prices on application.

### BRASS HANGER TEST WEIGHTS

These nickel plated weights are made of selected brass, with a steel knife edge hanger screwed in. They are indispensable for testing platform scales and steelyards. Price of larger sizes upon application.

No.	Weight	Price	No.	Weight	Price
9520	4 lb.	\$4.50	9524	4 oz.	\$2.25
9521	2 "	3.50	9525	2 "	2.00
9522	1 "	3.00	9526	1 "	1.75
9523	8 oz.	2.50			



9540

### FIFTY-POUND TEST WEIGHT

As the manufacturing industries vary in the different cities and towns, it is difficult to determine the number of 50 pound test weights necessary for a sealer's equipment. If scales of ten tons capacity or over are to be tested, one ton, or forty, of these weights are required, but in localities where the capacity of the scales does not exceed five tons, one-half ton, or twenty weights, will be found sufficient.

These weights are cast of a dense gray iron of the best quality, free from projections or blow holes. They are square in form, with smooth flat bottoms which allow them to be easily stacked. The handle is of round finished steel which makes them easy to carry and does not hurt the hand. They are accurately adjusted by means of a hole in the side of the weight near the top. This hole is covered with a removable screw, allowing the sealer to easily re-adjust when they become inaccurate through excessive wear. They are painted with a special aluminum paint, black or green enamel.

The shape of this weight is such that it is impossible

for dirt, snow, etc., to lodge under the handle and render it inaccurate. Attention is called to the fact that the defects in the ordinary type of fifty pound weight such as cast handles, screws or holes in the bottom, loose lead adjustment, insufficient accuracy, etc., are entirely eliminated by this method of construction.

No.	Weight	Price	No.	Weight	Price
9540 Aluminum	50 lb.	\$3.00	9543 Aluminum	20 kilograms	\$3.00
9541 Black	50 "	3.00	9544 Black	20 "	3.00
9542 Green	50 "	3.00	9545 Green	20 "	3.00

### DECIMAL AND FOREIGN WEIGHTS

We are prepared to furnish weights representing the decimal fractions of pounds and ounces. Also weights and measures to conform to the standards of foreign countries. Prices upon application.

### TRIPOD SCALE STAND

**No. 9546.** The sealer will find this stand useful in testing hanging scales such as ice and junk balances, beam scales, etc. A balance can be hung from the swivel hook and various articles such as coal, ice, etc., can be re-weighed.

The stand consists of a re-finished instrument tripod with swivel hook, and will easily support 500 lbs. It is very compact and can be folded in a small space.

Price . . . . . \$5.00

**No. 9547.** Same as above but with the addition of a straight spring balance of 125 lbs. capacity.

Price . . . . . \$9.00

### FOLDING PLATFORM SCALES

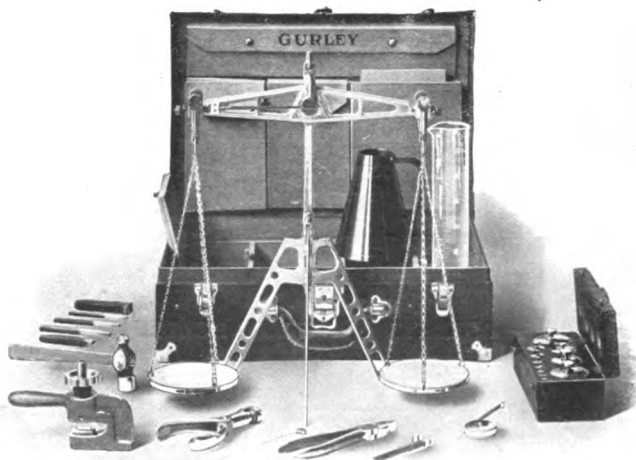
#### (ARMY AND NAVY TYPE)

These scales require two men to handle them, but are convenient where they can be set on a level place for some time.

**No. 9548.** Capacity, 600 lbs., platform, 17 x 22½ in.

**No. 9549.** Capacity, 300 lbs., platform, 13 x 18¾ in.

Prices on application.

**9550****9551**

**PORTABLE SEALING OUTFITS**

These outfits are indispensable for light sealing work when the sealer is not provided with a conveyance. They contain all the apparatus necessary for testing and sealing the ordinary retail store scales, measures, etc. A fairly complete equipment can be made up by adding to either of these outfits ten and five pound grip handle weights, 9552, and a suitable number of 50 pound weights for testing the platform scales.

**No. 9550.** Consists of a sole leather covered case  $16\frac{3}{4} \times 13\frac{1}{4} \times 4\frac{1}{2}$  inches with leather covered steel handle, two combination locks and catches. The case is strong though of very light construction, divided into compartments to contain the apparatus, with three pockets on the inside of the cover for certificate book, tags, etc. Liquid measures can be conveniently tested with the set of nested measures, the dry measures being tested by the gauge. The weight of outfit complete is approximately 31 lbs.

It contains the following apparatus:

9560	Balance	10168	One steel stamp $\frac{3}{8}$ " C. D.
9680	Balance stand	10166	" " " $\frac{1}{8}$ "
9920	Set of liquid measures	10168	" " " $\frac{3}{8}$ "
9305	Nickel-plated weights	10290	Small hammer
9156	Steel tape	10385	Cutting pliers
10238	Seal press	10314	Spring scale wrench
10243	200 lead seals	10280	Set of punches
10531	500 gummed seals	10285	Two lbs. lead wire
10548	200 condemning tags	10376	Screw driver
10501	Two certificate books	10377	Screw driver
10069	Dry measure gauge	10264	One line stencil
10135	Sealing clamp, 3 letters	10265	Stencil paste and brush
10269	Pocket spirit level		Bottle of shot
Price, complete.....			\$110.00

**PORTABLE SEALING OUTFITS**

**No. 9551.** Similar to 9550 but with dimensions 20 x 14 x 5½ inches and containing the following apparatus:

9560	Balance	10501	Two certificate books
9680	Balance stand	10168	One steel stamp ⅜" C. D.
9612	Liquid quart measure	10166	" " " ⅛"
9845	Cubic inch graduate	10168	" " " ⅜"
9305	Brass weights	10314	Spring scale wrench
10238	Seal press	10280	Set of punches
10069	Dry measure gauge	10285	Two lbs. lead wire
10243	200 lead seals	10135	Sealing clamp 3 letters
10531	500 gummed seals	9156	Steel tape
10548	200 condemning tags	10376	Screw driver
10290	Small hammer	10377	Screw driver
10385	Cutting pliers		Bottle of shot
Price, complete.....			\$93.00

Price of case only, 9550 or 9551, fitted with inside partitions for the apparatus . . . . . \$14.50

**PORTABLE WEIGHT SET**

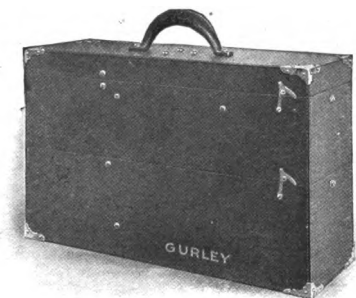
In many cases it is desired to carry extra weights in connection with sealing outfit 9550 or 9551. This set can be carried in the other hand, making the total of weights approximately 21 lbs.

**No. 9552.** Consists of a sole leather covered case with handle, containing one each ten and five pound nickel plated grip handle weights. Price . . . . . \$15.00

**9553****PORTABLE INSPECTION OUTFIT**

This is the lightest and most practical outfit for work such as supervisory and irregular inspections, checking the weights of commodities, etc. The sole leather covered case is very light but strong, the apparatus being fitted in separate compartments and firmly secured. Pockets are provided on the inside of the cover for reports, tags, etc. The dimensions are 17 x 12 x 4½ inches, weight 20 lbs.

**No. 9553.** Contains 9560 balance, 9680 balance stand, set of nickel plated weights, two 2 lbs. to two ⅛ oz., 9845 cubic inch glass graduate, 10069 dry measure gauge, 9156 steel tape, 9378 set of grain weights. Price . . . \$70.00

**9554****PORTABLE INSPECTION SET**

This set will be found convenient for light inspection work, determining the weight of packages, etc.

**No. 9554.** Contains set of nickel plated weights, two 2 lbs. to two  $\frac{1}{32}$  oz., and portable balance 9560 in the upper compartment; in the lower compartment are fitted cubic inch glass graduate 9845, and dry measure gauge 10069.

The case is made of mahogany with six ounce black leather covering, hand sewed, and the metal trimmings are nickel plated. Catches and spring locks are also provided. Sufficient space is provided in the center and under the removable weight blocks for reports, tags, etc. The dimensions are 20 x 10 x 6 inches, weight 20 lbs.

Price . . . . . \$68.00

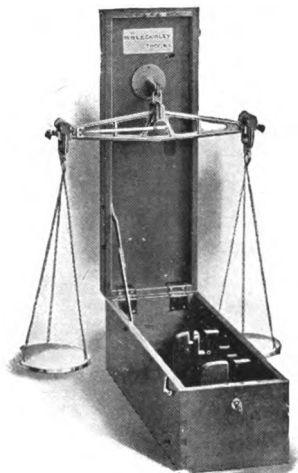
**No. 9555.** Similar to 9563 but with polished case.

Price . . . . . \$59.00

**COMBINATION BALANCE AND WEIGHT SET**

**No. 9556.** Consists of balance 9560 and weight set 9305, combined in one case. The weight box is removable and can be carried independently of the balance if desired.

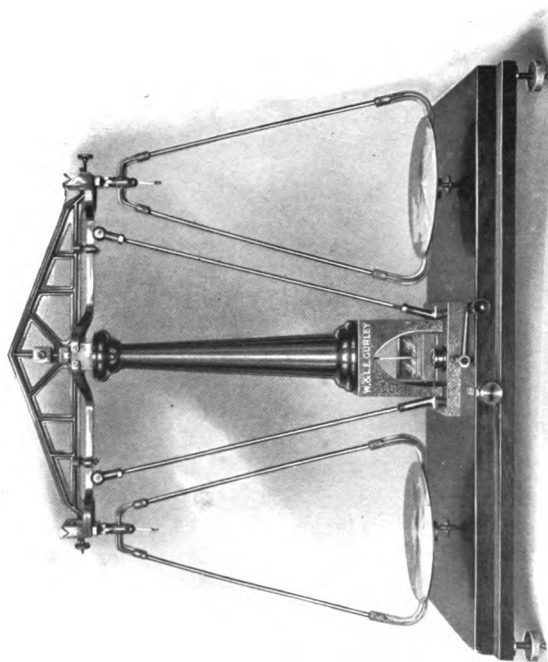
Price . . . . . \$49.00

**PORTABLE BALANCE****9560****MASSACHUSETTS PATTERN**

(Patented)

**No. 9560.** This balance has a capacity of ten pounds or four kilograms on each pan. It has been especially designed for sealer's use in going on a tour of inspection from store to store. It folds into a case 19x6x6 inches, and can be set up on any table or counter ready for use in less than ten seconds. The top of the case is raised, the beam with the attached pans is hung on the hook and the balance is ready for making test weighings. The parts have been so proportioned that it is light without sacrificing rigidity or accuracy. The beam is of aluminum, the other parts of nickel plated brass. The pans are slightly concave, so that shot or small objects cannot roll off. All parts are highly finished. The balance was originally designed for the sealers of the State of Massachusetts.

Price . . . . . \$35.00



9670

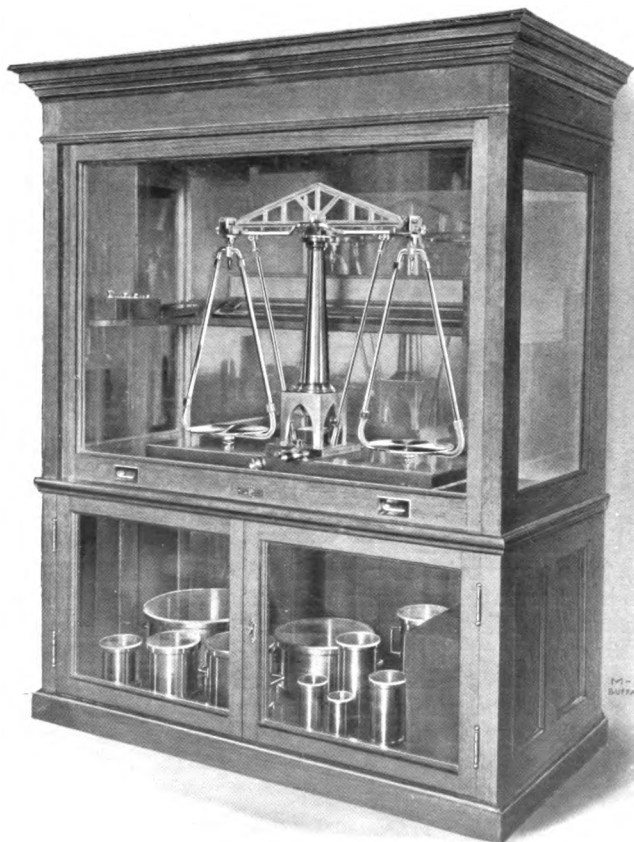
## LARGE OFFICE BALANCE

**No. 9570.** This balance has a capacity of fifty pounds or twenty-five kilograms on each pan, with a sensibility of one grain or .06 gram at full load. It is of an exceptionally rigid and stable construction and therefore admirably suited for mints, custom houses, the sealer's office, and in all cases where a large accurate balance is necessary. The beam and parts of the pan hangers are of aluminum, each member being of the ribbed construction, all the other metal parts are of bronze. The planes are of agate and the knife edges of hardened steel. The pointer swings over a horizontal scale, back of which is placed a mirror to facilitate the readings. A circular level is placed in front of the scale. The pans are provided with a spring arrestment. The beam arrestment is of the best three-point Mendeleeff type. The balance is highly finished. Length of base 40 inches. Width of base 15 inches. Height 40 inches.

Price . . . . . \$200.00

**No. 9591.** This short arm balance is made entirely of nonmagnetic material and has agate edges and planes. The beam is of a cold rolled aluminum alloy having more than three times the tensile strength of pure aluminum. This beam is oxidized black and graduated its entire length. The capacity of the balance is 200 grams or approximately 8 ounces with a sensibility of  $\frac{1}{20}$  milligram. The finish and workmanship are of the best, all brass parts being gold plated. The case is made of well seasoned mahogany with glass top, sides and front.

Price . . . . . \$125.00

**9675****Fitted with balance 9570 and Standards equipment.**

**EQUIPMENT CABINET**

This cabinet is made of well seasoned quartered oak, highly polished and with golden oak finish. It is solidly constructed in the best possible manner, with doors and sides of crystal plate glass, and bronze trimmings. Locks and keys are also provided.

It is six and one-half feet high, five feet wide, and two and one-quarter feet deep, divided into two compartments. The upper compartment is designed for holding the large office balance (see page 100), with shelves for the yard standard and weights, and is equipped with counterpoised sliding front door, mirror back and electric light. The lower compartment is to contain the dry and liquid capacity standards, and has hinged doors and panel back.

This cabinet is handsome and durable, and forms a very useful and ornamental part of the sealer's office equipment.  
Price . . . . . \$160.00

**BALANCE STAND**

(Illustrated on page 94.)

**No. 9680.** This nickeled stand for balance 9560 is of strong, though light construction and convenient to carry. It is very compact, folding into a space of 11 x 4½ x 1½ inches when closed. The hinged hook locks the tripod legs when opened, making it impossible to collapse. It is desirable for traveling inspectors and sealers, as both stand and balance can be packed in a small bag.

Price . . . . . \$3.00

**COMBINATION BALANCE AND STAND**

**No. 9685.** Consists of balance 9560 without box but with balance stand 9680.

Price . . . . . \$35.00

## GRADUATES

These graduates are standard at 15 degrees Centigrade or 59 degrees Fahrenheit and are tested after graduation. The readings are to be made at the bottom of the meniscus.

We are also prepared to furnish special standard graduates to conform to National Bureau of Standards specifications. Prices of these are necessarily much higher and will be quoted upon application.

### CONE SHAPED

No.	To Deliver	Price	No.	To Deliver	Price
9790	60 minims	\$0.45	9797	6 ounces	\$0.70
9791	120 "	.50	9798	8 "	.80
9792	1/2 ounce	.45	9799	12 "	1.00
9793	1 "	.45	9800	16 "	1.20
9794	2 "	.55	9801	32 "	1.90
9795	3 "	.60	9802	64 "	3.70
9796	4 "	.65			
9806	5 c. c.	.40	9811	120 c. c.	.70
9807	10 "	.45	9812	250 "	1.00
9808	15 "	.50	9813	500 "	1.50
9809	30 "	.55	9814	1000 "	2.60
9810	60 "	.60			



### CYLINDRICAL GRADUATES

APOTHECARIES'			METRIC		
No.	To Deliver	Price	No.	To Deliver	Price
9830	32 ounces	\$3.00	9836	1000 c. c.	\$3.35
9831	16 "	1.60	9837	500 "	2.00
9832	8 "	1.00	9838	250 "	1.35
9833	4 "	.90	9839	100 "	1.05
9834	2 "	.80	9840	50 "	.95
9835	1 "	.65	9841	25 "	.65
			9842	10 "	.60
			9843	5 " in 1/2 c. c.	.75

## CUBIC INCH GRADUATES

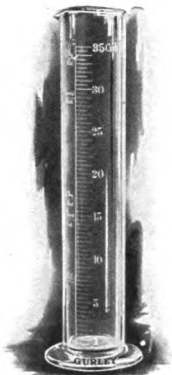
In many cases it is desirable to find the excess or deficiency of measures directly in cubic inches. The error can be then compared with the number of cubic inches in the standard. The difference between the liquid and dry measures can also be clearly shown.

No.		Price
9845	Cylindrical graduate, graduated by $\frac{1}{2}$ cu. in. to 35 cu. in. It is also marked with the following measures: dry pint and $\frac{1}{2}$ pint; liquid pint, $\frac{1}{2}$ pint and gill, combining five measures.....	\$2.50

9846	Cylindrical graduate 10x1 $\frac{1}{2}$ inches, graduated by $\frac{1}{2}$ cu. in. to 10 cu. in. on one side and by 2 drachms to 6 ounces on the other.....	1.25
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9760



9845

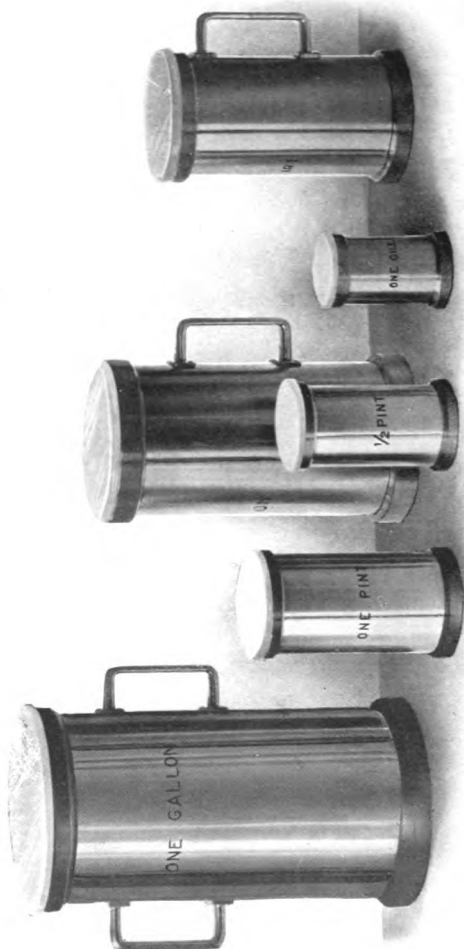
## BURETTES WITH GLASS STOPCOCKS

No.	Divisions	Contents	Price
9760	$\frac{1}{2}$ c. c.	100 c. c.	\$6.75
9761	$\frac{1}{10}$ "	50 "	6.50
9762	$\frac{1}{10}$ "	25 "	5.25
9763	$\frac{1}{20}$ "	10 "	4.00

## BURETTE HOLDER

**No. 9765.** This holder consists of a stable tripod, nickel-plated steel upright and an adjustable cork lined clamp.

Price . . . . . \$2.25



9850

## LIQUID CAPACITY MEASURES

### NATIONAL BUREAU OF STANDARDS DESIGN

These measures are made according to the designs and specifications of the National Bureau of Standards which require an accuracy to within one part in 10,000. They represent the finest and most permanent type of construction. Each measure is provided with a glass "slicker" plate and is carefully adjusted with distilled water, making the necessary corrections for temperature, etc., in strict conformity with the Government Standards.

**No. 9850.** Set of measures including the following: 1 gallon,  $\frac{1}{2}$  gallon, 1 quart, 1 pint,  $\frac{1}{2}$  pint, 1 gill.

Price . . . . . \$135.00

**No. 9851.** Set of measures including the following: 4 liters, 2 liters, 1 liter,  $\frac{1}{2}$  liter, 1 deciliter.

Price . . . . . \$125.00

Single measures similar to the above:

No.	Capacity	Price	No.	Capacity	Price
9855	1 gallon	\$50.00	9862	4 liters	\$50.00
9856	$\frac{1}{2}$ "	35.00	9863	2 "	35.00
9857	1 quart	18.00	9864	1 liter	18.00
9858	1 pint	14.00	9865	$\frac{1}{2}$ "	14.00
9859	$\frac{1}{2}$ "	10.00	9866	2 deciliters	10.00
9860	1 gill	8.00	9867	1 deciliter	8.00

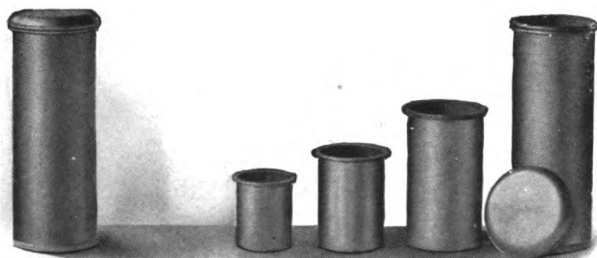
**LIQUID CAPACITY MEASURES****CYLINDRICAL PATTERN**

These measures are similar in form to the design of the National Bureau of Standards, but are of lighter construction, being provided with a ribbed brass strengthening bottom and a top rim. Each measure is accurately adjusted with distilled water in conformity with the Government Standard requirements.

No.		Price
9890	Set of nickel plated measures (1 gallon, $\frac{1}{2}$ gallon, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill and 2 oz. glass graduate). The last five are in a carrying case.....	\$45.00
9891	Set of nickel plated measures (1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill and 2 oz. glass graduate), in a carrying case ..	26.00
9894	Set of nickel plated measures (4 liters, 2 liters, 1 liter, $\frac{1}{2}$ liter, 1 deciliter and 50 c. c. glass graduate), the last four in a carrying case .....	39.00
9895	Set of nickel plated measures (1 liter, $\frac{1}{2}$ liter, 1 deciliter and 50 c. c. glass graduate), in a carrying case.	20.00

Single measures similar to the above:

NICKEL PLATED					
No.	Capacity	Price	No.	Capacity	Price
9900	1 gallon	\$10.00	9907	4 liters	\$10.00
9901	$\frac{1}{2}$ "	9.00	9908	2 "	9.00
9902	1 quart	8.00	9909	1 liter	8.00
9903	1 pint	6.60	9910	$\frac{1}{2}$ "	6.60
9904	$\frac{1}{2}$ "	6.10	9911	1 deciliter	5.60
9905	1 gill	5.60			

**Nested****Opened****9920****NESTED LIQUID MEASURES**

This type of liquid measure will be found the most practical and compact form for sealers and inspectors who carry their testing equipment in portable cases. The three smaller measures rest upon the top ring of the next larger size, being firmly held in place by the screw cover which prevents them from striking together. They are strongly constructed though very light, the set of four measures weighing only  $2\frac{1}{4}$  pounds.

**No. 9920.** Set of nickeled measures, 1 quart, 1 pint,  $\frac{1}{2}$  pint and 1 gill. Price . . . . . \$20.00

**9930**

## LIQUID CAPACITY MEASURES

## CONICAL PATTERN

These liquid capacity measures were originally suggested by Mr. D. C. Palmer, Commissioner of Weights and Measures for the Commonwealth of Massachusetts.

The shape of the measures makes them very convenient to handle and at the same time very stable. To avoid any alteration in capacity, the measures are made with ribbed brass bottoms and top strengthening rims. The handles are attached by screws. Each measure is carefully adjusted with distilled water, in strict conformity with the Government Standards and requirements.

No.		Price
9930	Set of nickel plated measures, 1 gallon, $\frac{1}{2}$ gallon, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill, and 2 oz. glass graduate (the last five in a carrying case) .....	\$40.00
9931	Set similar to No. 9930, but polished .....	38.00
9932	Set of nickel plated measures, 4 liters, 2 liters, 1 liter, $\frac{1}{2}$ liter, 1 deciliter and 50 c.c. glass graduate (the last four in a carrying case) .....	36.00
9933	Set similar to 9932, but polished .....	34.00
9934	Set of nickel plated measures, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill, 2 oz. glass graduate in carrying case .....	22.00
9935	Set similar to No. 9934, but polished .....	21.00
9936	Set of measures consisting of 1 gallon, 1 quart, polished, and No. 9845 cubic inch glass graduate .....	20.00

Single measures similar to the above:

NICKEL PLATED			POLISHED		
No.	Capacity	Price	No.	Capacity	Price
9940	1 gallon	\$12.50	9952	1 gallon	\$12.00
9941	$\frac{1}{2}$ "	8.50	9953	$\frac{1}{2}$ "	8.00
9942	1 quart	6.50	9954	1 quart	6.25
9943	1 pint	5.00	9955	1 pint	4.75
9944	$\frac{1}{2}$ "	4.00	9956	$\frac{1}{2}$ "	3.75
9945	1 gill	3.50	9957	1 gill	3.25
9947	4 liters	12.50	9959	4 liters	12.00
9948	2 "	8.50	9960	2 "	8.00
9949	1 liter	6.50	9961	1 liter	6.25
9950	$\frac{1}{2}$ "	5.00	9962	$\frac{1}{2}$ "	4.75
9951	1 deciliter	3.50	9963	1 deciliter	3.25



9600

## LIQUID CAPACITY MEASURES

## CONICAL PATTERN

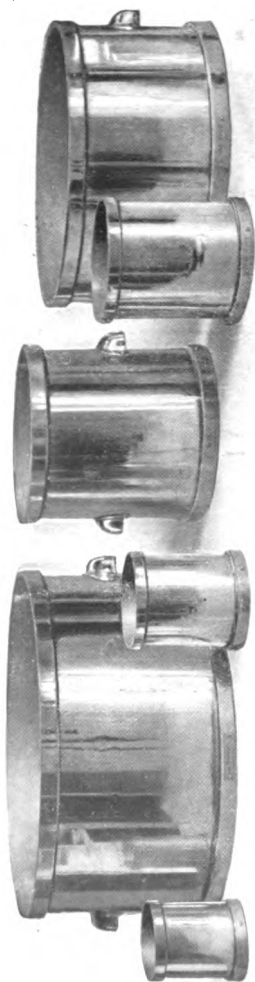
Lighter construction

Each measure is carefully adjusted with distilled water, in conformity with the Government Standards and requirements. They are finished in dull nickel and polished brass.

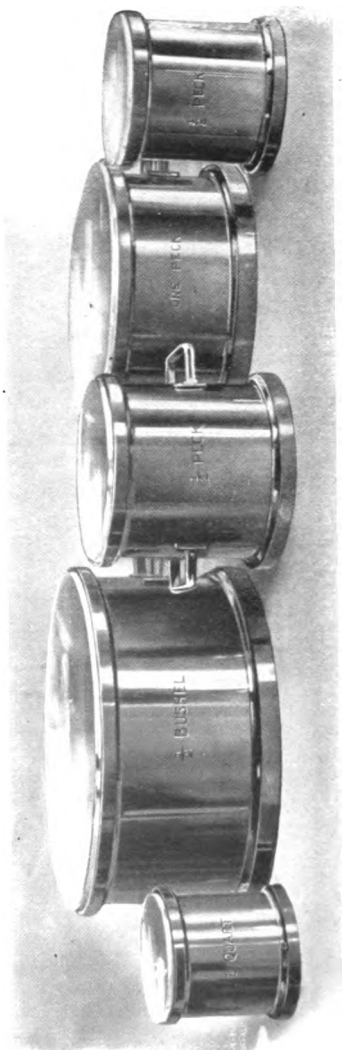
No.		Price
9600	Set of nickel plated measures, 1 gallon, $\frac{1}{2}$ gallon, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill, 2 ounce glass graduate (the last five in a carrying case).....	\$35.00
9601	The same as set 9600, but without case and graduate.	31.00
9602	Set similar to 9600, but polished.....	33.00
9603	Set similar to 9601, but polished.....	30.00
9604	Set of nickel plated measures, $\frac{1}{2}$ gallon, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill, 2 ounce glass graduate (the last five in a carrying case).....	25.00
9605	Set similar to 9604, but without case.....	21.00
9606	Set of nickel plated measures, 1 quart, 1 pint, $\frac{1}{2}$ pint, 1 gill, 2 oz. glass graduate, in case.....	21.00
9607	Set of nickel plated measures, 1 quart, 1 pint, $\frac{1}{2}$ pint, 2 oz. glass graduate, in case.....	18.00
9608	Set similar to 9607, but without case.....	14.00

Single measures similar to the above:

DULL NICKEL PLATED			POLISHED		
No.	Capacity	Price	No.	Capacity	Price
9610	1 gallon	\$10.00	9621	1 gallon	\$9.75
9611	$\frac{1}{2}$ "	7.25	9622	$\frac{1}{2}$ "	7.00
9612	1 quart	6.00	9623	1 quart	5.75
9613	1 pint	4.75	9624	1 pint	4.50
9614	$\frac{1}{2}$ "	3.75	9625	$\frac{1}{2}$ "	3.25
9615	1 gill	3.25	9626	1 gill	3.00
9616	4 liters	10.00	9627	4 liters	9.75
9617	2 "	7.25	9628	2 "	7.00
9618	1 liter	6.00	9629	1 liter	5.75
9619	$\frac{1}{2}$ "	4.75	9630	$\frac{1}{2}$ "	4.50
9620	1 deciliter	3.25	9631	1 deciliter	3.00



10000



9970

**DRY CAPACITY MEASURES****NATIONAL BUREAU OF STANDARDS DESIGN**

These measures are made according to the designs and specifications of the National Bureau of Standards, and represent the finest and most permanent type of construction. They are made of heavy brass tubing with extra rigid base and rim. Adjustment is made with distilled water, making the necessary corrections to a degree of one part in 10,000. These measures were designed for State Standards.

No.		Price
9970	Set of measures, each with a "slicker" or cover plate of glass, $\frac{1}{2}$ bushel, 1 peck, $\frac{1}{2}$ peck, $\frac{1}{4}$ peck, 1 quart, 1 pint, $\frac{1}{2}$ pint .....	\$312.00
9971	Set of metric measures similar to No. 9970, 2 dekaliters, 1 dekaliter, $\frac{1}{2}$ dekaliter, 2 liters, 1 liter.....	288.00

Single measures similar to the preceding:

No.	Capacity	Price	No.	Capacity	Price
9975	$\frac{1}{2}$ bushel	\$110.00	9981	2 dekaliters	\$110.00
9976	1 peck	75.00	9982	1 dekaliter	75.00
9977	$\frac{1}{2}$ "	50.00	9983	$\frac{1}{2}$ "	50.00
9978	$\frac{1}{4}$ "	35.00	9984	2 liters	35.00
9979	1 quart	18.00	9985	1 liter	18.00
9980	1 pint	14.00	9986	$\frac{1}{2}$ "	14.00
9987	$\frac{1}{2}$ pint	10.00			

**DRY CAPACITY MEASURES**

These measures are punched from one piece of metal and are made with a ribbed brass strengthening bottom and a top rim. They are very carefully adjusted by weighing with distilled water, applying the necessary temperature corrections. They are light but rigid and the handles are so attached that the measures may be nested.

No.		Price
10000	Set of nickel plated measures as follows: $\frac{1}{2}$ bushel, 1 peck, $\frac{1}{2}$ peck, $\frac{1}{4}$ peck, 1 quart, 1 pint . . . . .	\$55.00
10001	Set of nickel plated measures as follows: 2 dekaliters, 1 dekaliter, $\frac{1}{2}$ dekaliter, 1 liter, $\frac{1}{2}$ liter . . . . .	46.00

Single measures similar to the above.

No.	Capacity	Price	No.	Capacity	Price
10005	$\frac{1}{2}$ bushel	\$13.50	10012	2 dekaliters	\$13.50
10006	1 peck	12.75	10013	1 dekaliter	12.75
10007	$\frac{1}{2}$ "	11.50	10014	$\frac{1}{2}$ "	11.50
10008	$\frac{1}{4}$ "	9.50	10015	1 liter	7.00
10009	1 quart	7.00	10016	$\frac{1}{2}$ "	6.00
10010	1 pint	6.00	10017	2 deciliters	5.50
10011	$\frac{1}{2}$ "	5.50			

### WOODEN DRY MEASURES, SQUARE FORM

These measures are carefully and accurately made of well dried wood. They are strongly dovetailed, the two and one bushel measures having brass corner pieces on the bottoms and bound around the top with brass. Adjustment is made to an accuracy of one part in 200. These measures are very light and convenient and form a practical working standard.

No.	Capacity	Price
10020	Two bushel . . . . .	\$8.00
10021	One bushel . . . . .	6.50
10022	One-half bushel . . . . .	2.50
10023	One peck . . . . .	2.00
10024	One-half peck . . . . .	1.65
10025	Two quarts . . . . .	1.35
10026	One quart . . . . .	1.25
10027	One pint . . . . .	1.00
10030	Set consisting of $\frac{1}{2}$ bushel, 1 peck, $\frac{1}{2}$ peck, 2 quarts, 1 quart, 1 pint. Price . . . . .	9.00

**10041****HOPPER FUNNEL**

The hopper funnel is one of the most useful instruments a Sealer can have. Measures which do not hold water, such as wooden dry measures, baskets, boxes and bags can be accurately and easily tested with this device, using flaxseed, wheat or beans. It is invaluable for testing by comparison with the standard or in any case where accurate results are desired.

**No. 10041.** Adjustable funnel, can be raised for large and lowered for small measures. The base board can be raised on one end and held in position by an automatic catch, allowing the excess grain to be recovered easily; or the base board can be removed, leaving an open space for convenience in testing baskets or bags. Price . . \$15.00

**No. 10042.** This pattern is of the same construction as 10041, except that it has a square pan instead of the base board, allowing the funnel to be operated on the floor.

Price . . . . . \$15.00



### ALUMINUM DRY OR BERRY MEASURES

These measures are light and convenient to carry. The measures may be nested. They are accurately adjusted with distilled water and are marked on the inside with rings denoting the nearest liquid measure.

**No. 10044.** Set of measures consisting of 1 quart, 1 pint and  $\frac{1}{2}$  pint . . . . . \$15.00

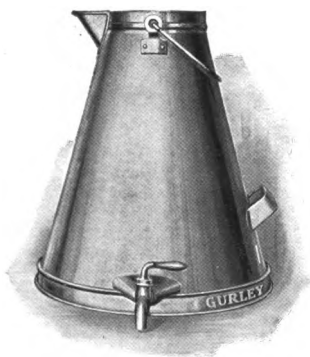
Single measures similar to the above:

No.	Size of Measure	Price	No.	Size of Measure	Price
10045	1 quart	\$6.00	10047	1 liter	\$6.00
10046	1 pint	5.00	10048	$\frac{1}{2}$ "	5.00
10049	$\frac{1}{2}$ "	4.50			

### WOODEN DRY CAPACITY MEASURES

**No. 10035.** These are the best sealed, iron bound, and varnished wooden measures carefully adjusted to an accuracy of one part in 200. They are a good working set for the Sealer. The set includes  $\frac{1}{2}$  bushel, 1 peck,  $\frac{1}{2}$  peck,  $\frac{1}{4}$  peck, and 1 quart.

Price per set . . . . . \$3.00

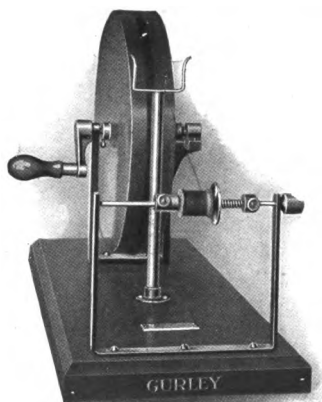


9870

**LARGE BUCKET MEASURES**

These measures are made of heavy copper, with reinforced bottom, pouring spout, faucet and heavy brass handle. They are accurately adjusted with distilled water, the necessary temperature corrections being made.

No.	Capacity	Price
9868	Two gallons.....	\$ 20.00
9869	Three " .....	21.00
9870	Five " .....	25.00
9871	Twenty liters.....	25.00
9872	Five gallon measure, National Bureau of Standards form.....	100.00

**10068****MEASURING REELS**

**No. 10068.** In a number of localities the Sealer is called on to measure the amount of thread on spools, twine, etc. This is done by weighing a known length and then from the weight of the whole the total amount is calculated. Or, another method is to measure the total length directly by winding on a standard size reel. The circumference of this reel is exactly one yard; a counter gives the number of turns and then the exact number of yards are indicated. A spring catch holds the ends of the thread. The tension is adjustable. Price . . . . . : \$45.00

**MEASURE GAUGES**

**No. 10069.** Gurley Pattern (patent applied for). This is the most practical and convenient gauge devised for Sealers, and the cubical contents of any cylindrical, rectangular or square dry measure within its range can be determined by it. It consists of a brass bound folding rule, 2 feet long, with figures for the depths on one side and the diameters on the other. When testing, the figures denoting

the depths and diameters of the measures are added together and the results should be as follows: 100 for the bushel; 90 for the  $\frac{1}{2}$  bushel; 80 for the peck; 70 for the  $\frac{1}{2}$  peck; 60 for the  $\frac{1}{4}$  peck; 50 for the quart; 40 for the pint; 30 for the  $\frac{1}{2}$  pint; 20 for the  $\frac{1}{4}$  pint. Full directions for using are sent with each gauge.

Price . . . . . \$2.00

**No. 10070.** This gauge is in the form of a three fold brass rule which is marked with the diameters and the corresponding depths of the ordinary standard dry measures. It is a very convenient tool, by which the sealer can ascertain in a moment whether a measure is far out or not. Price . . . . . \$1.50

**No. 10072.** Marsh pattern. This gauge consists of a folding two foot brass bound rule, upon which the depths and diameters of 70 cylindrical dry measures are indicated by letters on the edges. Full directions for using are sent with each gauge.

Price . . . . . \$2.00

**No. 10073.** Gauge for approximately determining the number of gallons contained in a barrel or hogshead. The capacity is ascertained by inserting the gauge through the bung hole into each end, reading the rod across the center of the bung hole for both insertions and then taking the average of the two readings. Price . . . . . \$0.35

### STRIKING STICK

**No. 10075.** Striking stick of nickel plated brass, with mahogany handle. It is essential for the sealer in ascertaining strike measure. Price . . . . . \$1.00

### GLASS COVER OR SLICKER PLATES

No.		Price
10076	15 $\frac{1}{2}$ -inch "slicker" or cover plate for $\frac{1}{2}$ bushel or 1 peck measure. . . . .	\$2.00
10077	8-inch "slicker" plate for $\frac{1}{2}$ peck measure. . . . .	1.00
10078	2-inch to 5-inch "slicker" plates for small measures. . . . .	.50

**STEEL LETTERS AND FIGURES**

These machine cut letters and figures are packed in a wooden case. They are made of the best hardened steel and the temper carefully drawn, so that they may be used on all metals.

No.			Price
10107	Set of figures	$\frac{1}{16}$ in.....	\$ 0.90
10108	" " "	$\frac{1}{8}$ " .....	.90
10109	" " "	$\frac{1}{4}$ " .....	1.50
10110	" " "	$\frac{3}{8}$ " .....	2.50
10111	" " "	$\frac{1}{2}$ " .....	4.50
10112	" " Alphabet	$\frac{1}{16}$ " .....	2.70
10113	" " "	$\frac{1}{8}$ " .....	2.70
10114	" " "	$\frac{1}{4}$ " .....	4.50
10115	" " "	$\frac{3}{8}$ " .....	7.50
10116	" " "	$\frac{1}{2}$ " .....	13.50
10117	Single letter or figure	$\frac{1}{16}$ in.....	.15
10118	" " " "	$\frac{1}{8}$ " .....	.15
10119	" " " "	$\frac{1}{4}$ " .....	.20
10120	" " " "	$\frac{3}{8}$ " .....	.35
10121	" " " "	$\frac{1}{2}$ " .....	.50

**STEEL DIES FOR MEASURES AND WEIGHTS**

These dies are hand made, properly tempered and will mark cast iron weights without breaking or wearing down. The larger dies for wooden measures have deep, sharp cut letters and will make a permanent impression. All dies are warranted.

**No. 10165.**  $\frac{1}{16}$  inch letters for marking tin measures and weights. Price per letter . . . . . \$0.15

**No. 10166.**  $\frac{1}{8}$  inch letters for marking tin measures and weights. Price per letter . . . . . \$0.15

**No. 10167.**  $\frac{1}{4}$  inch letters for marking the larger weights and measures. Price per letter . . . . . \$0.35

**No. 10168.**  $\frac{3}{8}$  inch letters for marking wooden measures, etc. Price per letter . . . . . \$0.50

**No. 10169.**  $\frac{1}{2}$  inch letters for marking wooden measures, etc. Price per letter . . . . . \$0.75

No.		Price
10170	$\frac{1}{16}$ inch die "Condemned"	\$1.25
10171	$\frac{1}{8}$ " " "	1.25
10172	$\frac{1}{4}$ " " "	3.00
10173	$\frac{3}{8}$ " " "	4.00
10174	$\frac{1}{2}$ " " "	6.00
10175	$\frac{3}{8}$ " canceling die	0.35

### STAND FOR SPRING BALANCES

**No. 10090.** This stand will be found very convenient for testing spring scales at the office or when demonstrating in court. It is strong and rigid and will easily support 50 pounds. It consists of tripod base into one leg of which is screwed a nickel plated steel rod,  $3\frac{1}{2}$  feet high, terminating with a hook at its curved end.

Price . . . . . \$5.00

### SEALER'S BADGE

**No. 10096.** This nickel plated badge has convex front and is provided with a strong catch pin.

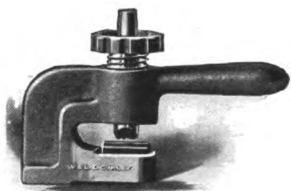
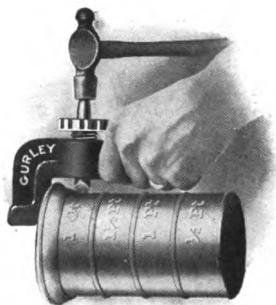
Price . . . . . \$1.00

**No. 10097.** Same as No. 10096, but with the word "POLICE" engraved on badge beside the inscription.

Price . . . . . \$1.00

### ROUND SEALING BLOCK

**No. 10128.** This is a new and improved form of block and is used by Sealers as a base when stamping weights. It is made of nickel plated cast iron, with raised disc on top. The disc forms a solid backing for platform scale weights, allowing them to be stamped without breaking. Holes are provided that knob weights may be stamped on the bottom. Price . . . . . \$1.75

**10134****10134****10128****10132**

**SEALER'S ANVIL OR STAKE**

Used for stamping measures. With lead covered horn to protect the steel dies or stamps.

**No. 10130.** This anvil is made of steel and fits into a cast iron socket base. Price complete . . . . . \$8.25

**No. 10131.** Extra socket base to fit No. 10130.

Price . . . . . \$1.50

**No. 10132.** Made of iron with set of three sleeves or guides. Price . . . . . \$3.00

**No. 10133.** Extra sleeves or guides for No. 10132. Price per set of three . . . . . \$0.75

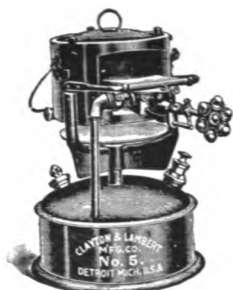
**LIGHT SEALING CLAMP FOR STAMPING TIN AND  
WOODEN MEASURES**

(Patent Allowed March 30, 1912)

This nickel plated sealing clamp has a removable die which is clamped to the measures by means of the hollow screw. The die is then struck with a light hammer and a perfect impression is obtained. A brass backing piece is screwed to the under jaw, forming a reverse die, hence the stamp will not cut through the tin. It is quickly applied and very light, weighing only 2½ lbs. It is convenient to carry and takes the place of the heavy and awkward sealers anvil. The die can be removed each year and a new one substituted.

No.		Price
10134	With ⅛-inch, 3 letters or figures.....	\$5.00
10135	“ ⅜ “ 3 “ “ “ .....	5.00
10136	“ ¼ “ 3 “ “ “ .....	5.00
10138	Extra die for sealing clamp, with 3 letters or figures ⅛, ⅜ or ¼ inch, and matrix.....	2.50

**NOTE.**—If extra letters are required, add prices of hand cut letters on page 122. On account of the limited space in this clamp, it is advisable to use as few letters as possible.

**10200****BRANDING IRON HEATER**

No.		Price
10200	This gasoline furnace produces an intense heat and works well in any wind. It is provided with a first class brass air pump.....	\$5.50

**BRANDING IRONS**

These irons are used for marking or sealing wooden measures. Being made of bronze, they will heat very quickly in an ordinary fire or in heater No. 10200. The letters are  $1\frac{1}{2}$  inch high.

No.		Price
10205	With 3 letters or figures on one line.....	\$1.40
10206	" 4 " " " " .....	1.50
10207	" 5 " " " " .....	1.65
10208	" 6 " " " " .....	1.75
10209	" 7 " " " " .....	2.00
10210	" 8 " " " " .....	2.25
10211	" 9 " " " " .....	2.50

**ELECTRIC BRANDING IRONS**

**No. 10215.** This tool can be attached to the ordinary incandescent lamp socket, will heat in three minutes and stay hot. The die is removable and can be renewed annually. When a measure is to be condemned, the sealing die may be removed by unscrewing and the condemning die substituted. When ordering, please specify the voltage desired.

Price with 2 inch die . . . . . \$14.50

**No. 10216.** 2 inch die plate only . . . . . 4.50

# SEALED SHELBURNE 1912 10224 CONDEMNED 10220

## RUBBER STAMPS

These rubber stamps are made especially for marking glassware such as milk bottles, the ordinary rubber stamp not answering the purpose. They are mounted on air cushions and are provided with handles.

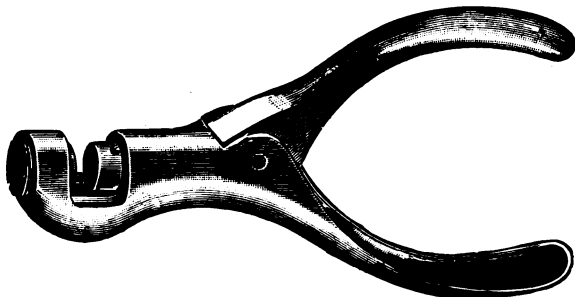
No.		Price
10220	Stamp with the word "CONDEMNED" .....	\$0.25
10221	Stamp with the letter "CD" .....	.20
10222	Stamp with one letter and the year, thus, "R. 12" Used in sealing glass measures.....	.25
10223	Stamp with two letters and the year, thus, "R. C. 12."	.25
10224	Stamp with three lines (see illustration above).....	.60
10225	Stamp with two lines similar to No. 10224, but with the date left off .....	.50

Prices of special rubber stamps with seals, etc., on application.

## GLASS INK AND PAD

No.		Price
10230	Glass ink for marking with a stamp or pen on glass, in four ounce rubber bottles, full directions accom- pany each bottle .....	\$1.75
10231	Special pad to be used with the glass ink when using the rubber stamps. An ordinary pad will soon cor- rode, besides not holding the ink necessary for this purpose.....	.85

**NOTE.**—Allowance of 40 cents each will be made for rubber bottles re-  
turned. Special prices on larger quantities of the glass ink.



### HAND SEAL PRESSES AND WIRED LEAD SEALS

**No. 10238.** This press is six inches long, weighs twelve ounces and can be carried in the pocket. The dies are of tool steel,  $9/16$  inch in diameter and will take any seal up to  $3/8$  inch in thickness. One die is engraved with the initial of the county, city or town, and the other with the last two figures of the year. The latter must be replaced annually. This press is easily operated with one hand, is very compact and powerful, heavily nickel plated and will last indefinitely.

Price with engraved dies . . . . . \$2.50

**No. 10239.** Extra dies for seal press No. 10238, engraved with a letter or with the year. Price each . . . \$0.60

**No. 10243.** Lead seals with  $9\frac{1}{2}$  inch tinned wires attached. Price per hundred . . . . . \$0.35

**No. 10244.** This seal press is of the single lever type and larger than No. 10238.

Price with dies engraved as above . . . . . \$2.25

**No. 10245.** Extra dies for No. 10244, engraved with a letter or with the year. Price each . . . . . \$0.60

## STENCILS

Many sealers prefer to mark dry capacity measures with a stencil instead of a stamp or branding iron. By this method the seal is plainly shown and can be readily seen. These stencils are carefully cut in brass with letters  $\frac{3}{4}$  inch high.

**No. 10264.** Price per letter or figure . . . . . \$0.06

**No. 10265.** Marking outfit consisting of stencil paste, brush and sponge in box. Price . . . . . \$0.50



10266

## POCKET SPIRIT LEVELS

## ADJUSTABLE AND IN WOODEN CASE

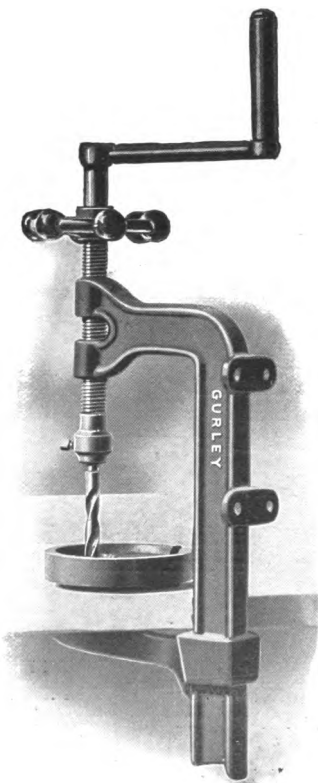
No.	Size	Price	No.	Size	Price
10266	6 in.	\$3.50	10267	10 in.	\$4.50

**No. 10268.** Pocket spirit level  $3\frac{1}{2}$  inches long for determining the level of counter scales, levers, etc. Price \$0.50

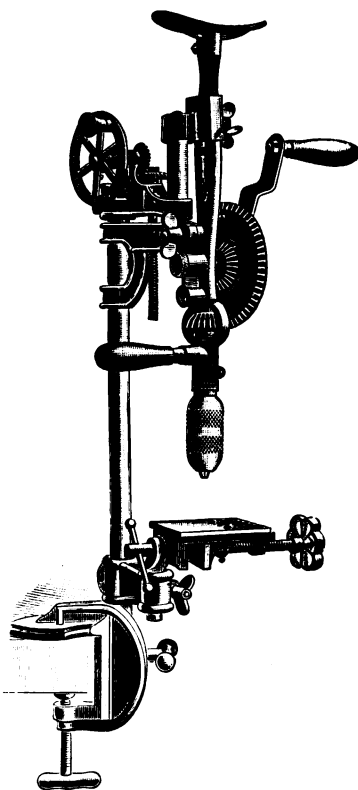
## POCKET TOOL KIT

**No. 10269.** Consists of leather case  $5 \times 5$  inches with cover secured by snap button, into which are fitted small level, side cutting nippers, pointer wrench and small screw-driver. This forms a very practical and convenient pocket tool outfit.

Price . . . . . \$3.50



10270



10279

**PORTABLE DRILL**

**No. 10270.** This portable drill is one of the most useful tools that the sealer can have, as it will clamp to any bench or table or to a wagon bed. Five twist drills are furnished. Price . . . . . \$3.00

**No. 10271.** Portable drill similar to No. 10270, but furnished with a universal chuck, capacity 0 to  $\frac{3}{8}$  inches. Price . . . . . \$6.50

**TWIST DRILLS FOR 10270**

No.	Size	Price	No.	Size	Price
10273	$\frac{3}{16}$ inch diameter	\$0.25	10277	$\frac{3}{8}$ inch diameter	\$0.25
10274	$\frac{1}{4}$ " "	.25	10278	$\frac{1}{2}$ " "	.25
10276	$\frac{5}{16}$ " "	.25			

**No. 10279.** Bench Drill. Of heavy construction and well made. The breast drill attachment can be unclamped and used independently. Reversible table with vise. Capacity of chuck, 0 to  $\frac{1}{2}$  inch.

Price with set of five twist drills . . . . . \$8.00

**HANGER WEIGHT**

This nickel plated weight is indispensable for testing steelyards and platform scales.

**No. 10275.** One-pound hanger weight, accurately adjusted.

Price . . . . . \$3.00

**PUNCHES**

**No. 10280.** Steel punches. A set of three,  $\frac{3}{16}$ ,  $\frac{1}{4}$ ,  $\frac{5}{16}$  inches, used to drive in lead when adjusting weights.

Price per set . . . . . \$0.30

**HOLLOW PUNCH OR POINTER SET**

**No. 10282.** This tool will be found useful in attaching pointers to dial spring balances. Price . . . . . \$0.25

**LEAD PLUGGING WIRE**

**No. 10285.** This lead wire is  $\frac{1}{4}$  inch in diameter. It is used by the sealer to adjust weights found to be light.

Price per pound . . . . . \$0.15

**HAMMERS**

**No. 10289.** Machinists' ball pein hammer, made of best cast steel, weight 1 lb. Price . . . . . \$0.75

**No. 10290.** Same as No. 10289 but weighing 8 oz.  
Price . . . . . \$0.60

**WRENCHES**

**No. 10303.** Nickel plated  $4\frac{1}{2}$  inch steel bicycle wrench.  
Price . . . . . \$0.60

**No. 10304.** Six inch monkey wrench, similar to No. 10305. Price . . . . . \$0.60

**No. 10305.** Monkey wrench. This knife handle screw wrench is used by the sealer when he wishes to tighten or loosen bolts or nuts. Such a case often occurs in adjusting large scales. Length, 8 inches. Price . . . . . \$0.75

**No. 10306.** Monkey wrench, similar to No. 10305, 10 inches long. Price . . . . . \$0.80

**No. 10307.** Stillson's pipe wrench. Used in conjunction with another wrench or whenever a round or irregular rod has to be firmly held or turned. Length, 10 inches.

Price . . . . . \$1.00

**No. 10308.** Pipe wrench, similar to No. 10307, 8 inches long. Price . . . . . \$1.00

**No. 10309.** Alligator wrench. Used in holding or turning any object. Price . . . . . \$0.25

**No. 10312.** Nose iron wrench for Fairbanks scales. This wrench is used to lengthen or shorten the leverage in a Fairbanks scale. The nose iron is found directly under the pillar. Price . . . . . \$3.00

**No. 10313.** Nose iron wrench for Howes platform scales. This serves the same purpose as No. 10312, but is for the Howe scales. Price . . . . . \$3.50

**No. 10314.** Wrench for spring balance pointers. The prongs of this wrench are placed over the pointer of the dial form of spring balance and the pointer turned to the right or left. Price . . . . . \$1.00

**No. 10315.** Lifter or claw for spring balance pointers. This tool is used when the pointer has to be removed. Price . . . . . \$0.50

### FILES AND EMERY

**No. 10325.** Wood rasp. This is used for filing the ends of wooden measures that are too long or for filing end wood when necessary. Price . . . . . \$0.45

**No. 10326.** Small triangular file. This is used for removing rust, etc., from sharp corners and angular places. Price . . . . . \$0.15

**No. 10327.** Small round file. This is used on curved surfaces and in testing the hardness of bearings and knife edges, when necessary. Price . . . . . \$0.15

**No. 10328.** Medium round file. This is used in the same manner as the small round file, but in larger places. Price . . . . . \$0.30

**No. 10329.** Emery cloth. This is used for removing rust or cleaning metal parts. Price per six sheets . . . \$0.30

### SCRAPER OR REAMER

**No. 10334.** Scraper or reamer. This is used to remove rust or rough places; also to enlarge holes or openings, or to take lead out of weights. Price . . . . . \$0.55

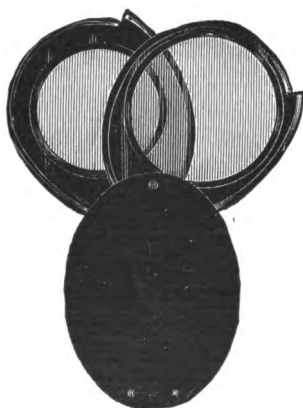
### CHISEL

**No. 10336.** Half inch chisel. A chisel is often used by the sealer for removing projecting parts of wooden bases and platforms. Price . . . . . \$0.45

**No. 10337.** One inch chisel. Price . . . . . .50

**No. 10336.** Center punch for stamping a dot on weights.

Price . . . . . \$0.20



10356



10365

### POCKET MAGNIFIERS

These magnifiers have oval rubber cases. The Sealer needs one constantly in making examinations.

No.	Size	Kind	Price
10350	1 in.	Single	\$0.40
10351	1½ "	"	.70
10355	2 "	"	1.15
10356	7/8 and 1 in.	Double	.65
10357	1¼ and 1½ in.	"	1.10
10360	High power aplanatic flat field magnifier,.....		1.00

### READING GLASSES

10365	Two-inch reading glass, metal frame, wood handle,..	\$0.80
10366	Three-inch " " "	.. 1.50

**SCREW DRIVERS**

- No. 10375.** Large screw driver. This screw driver is 19½ inches long and is used on large screws requiring considerable power; for instance, those on some platform scales. Price . . . . . \$1.00
- No. 10376.** Medium screw driver. This is used on large and medium sized screws. Price . . . . . \$0.35
- No. 10377.** Small screw driver. This is used on small screws, such as are found on small balances of almost all types. Price . . . . . \$0.25

**PLIERS**

- No. 10380.** Pipe pliers, 8 inches long. These are used for straightening or bending small rods, such as hanger and tie rods. Price . . . . . \$0.50
- No. 10385.** Flat nose side cutting pliers with scraper and screw driver ends on handle. The most convenient and universal pliers made. Price . . . . . \$0.90
- No. 10390.** Side cutting nippers of polished steel, 4 inches long. Very convenient for cutting lead seal wires. Price . . . . . \$0.75

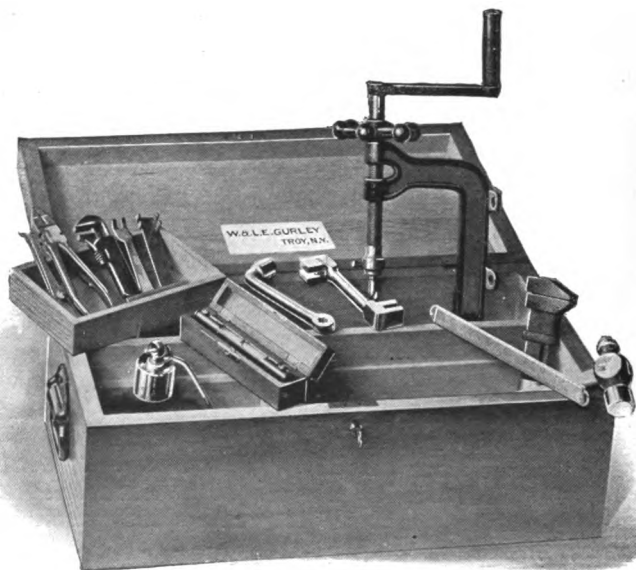
**TRANSFER SPRING CALIPERS**

These calipers are very useful in measuring the diameter of cylindrical measures and in transferring distances.

No.	Size	Price	No.	Size	Price
10410	6 in.	\$1.35	10412	10 in.	\$1.85
10411	8 "	1.60	10413	12 "	2.10

**CLEANING BLADE**

- No. 10420.** This tool has a strong wooden handle and a steel blade 3 feet long. It is used for removing stones, coal, etc., which lodge between the frame and the platform of wagon scales. Price . . . . . \$3.00



10461

### SEALERS' KIT OF TOOLS

Every practical Sealer should be provided with a kit of tools made for his needs in inspecting and, when necessary, correcting and adjusting. These tools are all of the best grade and are compactly arranged in a wooden chest with lock and handles. There is sufficient room in the sliding trays for dies, seals, punches, and other small articles which every sealer will accumulate.

**No. 10461.** This kit contains the following:

1 Nose iron wrench.....10312	1 Triangular file.....10326
1 Nose iron wrench.....10313	1 One pound hanger weight 10275
1 Pointer wrench.....10314	1 Measure gauge.....10069
1 Monkey wrench.....10305	1 Hammer.....10289
1 Bicycle wrench.....10303	1 Portable drill.....10270
1 Alligator wrench.....10309	1 Eight fold four foot rule.. 9168
1 Screw driver.....10375	1 Set punches.....10280
1 Screw driver.....10376	1 Pointer set.....10282
1 Screw driver.....10377	1 Bottle of shot.....
1 Pipe pliers.....10380	2 Pounds lead wire.....10285
1 Pocket level.....10266	1 Pointer remover.....10315
1 Flat nose pliers.....10385	6 Sheets emery cloth.....10329
1 Cutting nippers.....10390	1 Scraper or reamer.....10334
1 Rasp.....10325	1 Chisel.....10337
1 Round file.....10327	1 Transfer calipers.....10410
1 Round file.....10328	

Price complete with chest . . . . . \$37.00

**No. 10462.** This kit contains the following:

1 Nose iron wrench.....10312	1 Pointer remover.....10315
1 Nose iron wrench.....10313	1 Cutting nippers.....10390
1 Monkey wrench.....10304	1 Scraper or reamer.....10334
1 Pointer wrench.....10314	1 Eight fold four foot rule.. 9168
1 Pipe pliers.....10380	1 One pound hanger weight 10275
1 Flat nose pliers.....10385	1 Pocket level.....10268
1 Screw driver.....10375	1 Hammer.....10289
1 Screw driver.....10376	1 Portable drill.....10270
1 Screw driver.....10377	1 Set punches.....10280
1 Rasp.....10325	1 Bottle of shot.....
1 Triangular file.....10326	2 Pounds lead wire.....10285
6 Sheets emery cloth.....10329	

Price complete with chest . . . . . \$28.00

**No. 10463.** This kit contains the following:

1 Nose iron wrench.....10312	6 sheets emery cloth.....10329
1 Nose iron wrench.....10313	1 Scraper or reamer.....10334
1 Pointer wrench.....10314	1 Bottle of shot.....
1 Monkey wrench.....10304	1 Set punches.....10280
1 Flatnose pliers.....10385	1 Hammer.....10289
1 Screw driver.....10376	1 Portable drill.....10270
1 Screw driver.....10377	1 One pound hanger weight 10275
1 Round file.....10327	1 Pointer remover.....10315

Price complete with chest . . . . . \$24.00

**Department of Weights and Measures:**

No.

19

Mr. ....

Street.

Business .....

**To Sealing Weights and Measures as below:**

	Tagged for Repairs	Adjusted	Sealed	Condemned	Charges
Platform, over 5,000 lbs.,					
Platform, under 5,000 lbs.,					
Computing scale,					
Counter balance,					
Spring balance,					
Balance,					
Beam scale, over 1,000 lbs.,					
Butcher's scale,					
Slot weighing scales,					
Dry measures,					
Liquid measures,					
Yard measures,					
Measuring pumps,					
Weights,					
Baskets,					
Adjusting,					
New parts,					
Miscellaneous,					
Total,					

**Received Payment,** .....**Remarks** .....

This is to certify, That I have this day tried, adjusted, proved and sealed the above described balances, scales, weights and measures, according to the provisions of the law

Sealer of Weights and Measures

19

10501

**SEALERS' RECEIPT AND RECORD BOOK**

These duplicate receipt and record books are strongly bound in canvas cover with alternate leaves perforated. As the sealer inspects and tests any weights, scales or measures, he makes a record in this book. On completing his work at a certain place he tears out the original receipt and gives it to the owner of the apparatus tested. The carbon copy remains in the book as an official record to check fees (when fees are collected) and to make reports. Each book contains 200 sheets, 100 of each color, and is furnished with a carbon paper.

No. 10501. Price each.....\$1.00

**SEALER'S CERTIFICATE AND RECORD BOOK**

New York State Pattern.

**No. 10506.** This is the approved form of certificate book for sealers in the State of New York. Each book contains 150 pages in triplicate form, or 50 certificates, with carbon paper. Price each . . . . . \$0.50

**DUPLICATE CERTIFICATE AND RECORD BOOKS**

**No. 10508.** In localities where no fees are charged for testing and sealing this form of certificate book will be found the most convenient. Each book contains 200 sheets, 100 of each color, and is furnished with carbon paper.

Price each . . . . . \$0.50

NO.

# WEIGHTS AND MEASURES DEPARTMENT

## Record of Coal Re-Weighings

City or Town \_\_\_\_\_ 19\_\_

No. of Weight Certificate \_\_\_\_\_ Hour \_\_\_\_\_

Name of Seller \_\_\_\_\_ Place of Business \_\_\_\_\_

Name of Purchaser \_\_\_\_\_ Where to be Delivered \_\_\_\_\_

Name of Sworn Weigher \_\_\_\_\_ Name of Teamster \_\_\_\_\_

Certificate Demanded at \_\_\_\_\_ Scale Where Re-Weighed \_\_\_\_\_

### RESULTS OF WEIGHING

	Weight as indicated by Seller's Certificate	Weights as found by Sealer on Re-weighing
Gross Weight		
Tare		
Weight of Coal		
	Overweight _____ lbs	Underweight _____ lbs

Remarks: \_\_\_\_\_

\_\_\_\_\_ Sealer

10515

**COAL RE-WEIGHING BOOKS**

When the sealer re-weighs or re-measures coal it is important that he have an accurate record of the work done and the results. These books are printed in duplicate, 200 pages to a pad, alternate leaves are perforated and carbon paper is furnished. They are strongly bound, with canvas cover, and will lie flat when opened. Size, 4 x 6½ inches.  
No. 10515. Price each.....\$1.00

**NOT SEALED LABELS**

These labels are square in form and printed on gummed paper. They are necessary to mark scales, etc., which are not used for the purpose of buying or selling, with the words "Not Sealed," in accordance with the Massachusetts law.

No. 10521. Price per 100 .....\$0.40

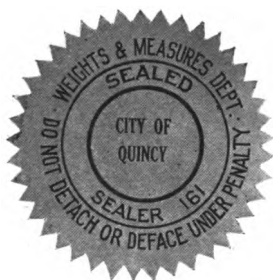
**OFFICE RE-WEIGHING BOOK**

**No. 10525.** This book forms an office record of the coal re-weighing made by the sealer. The book is bound in heavy linen canvas and has 500 pages, two records on each page. Price . . . . . \$4.50

**SEALERS' RECORD BOOK**

(Massachusetts Pattern)

**No. 10527.** This book forms an office record of all the work done by the sealer. It is properly ruled with headings printed on each page. The binding is of linen canvas. This book is 12 x 10 inches and contains 50 pages.  
Price . . . . . \$2.50



10530



10537

(Cuts Reduced Size)

### GUMMED PAPER SEALS

These seals are printed on the best quality glazed paper. They are 2 inches in diameter with notched rim, and when placed on a balance or scale can be easily seen. Great care has been exercised in securing extra strong adhesive gum, but in spite of that it is recommended that the surface to which they are attached be clean. If necessary, the sealer should remove grease by wiping the part of the scale with a slightly alkaline solution like soda or dilute potash. The seals are printed with the name or seal of the town, city, or county, as desired. (If the seal is desired, an electrotpe of the proper size must be furnished.)

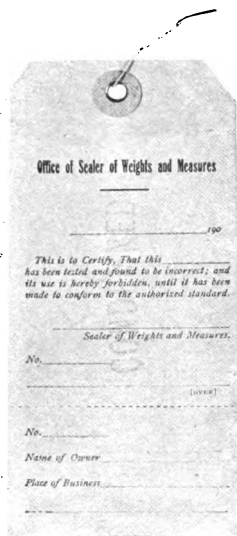
No.	Quantity	Price	No.	Quantity	Price
10530	300 or less seals	\$1.75	10531	500	\$2.00
10532	1000	2.40	10533	2000	4.50

### GUMMED SEALS FOR NEW YORK STATE SEALERS

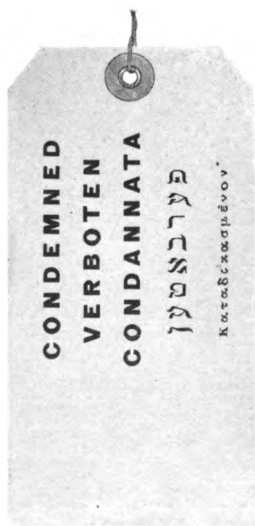
No.	Quantity	Price	No.	Quantity	Price
10537	300	\$1.25	10539	1000	\$2.40
10538	500	1.50	10542	500 square form	1.50
			10543	1000 "	2.40

### CONDEMNING TAGS

Sealers generally use condemning tags to mark scales, etc., which are found to be inaccurate yet may be repaired. These can be attached with a wired lead seal, making use of



10545



10554

the pliers (No. 10380 or No. 10385). The tags are wired and printed on heavy cardboard. The card is perforated near its lower end, so that the sealer may detach part of the tag and keep a record of the particular scale or other apparatus condemned for repairs.

No.	Quantity	Price	No.	Quantity	Price
10545	25 tags	\$0.25	10549	250 tags	\$1.00
10546	50 "	.35	10550	400 "	1.50
10547	100 "	.55	10551	500 "	1.75
10548	200 "	.85	10552	1000 "	3.00

## RED CONDEMNING TAGS

These red condemning tags are similar in form to 10545 but have the word "Condemned" printed on the reverse side in five languages.

No.	Quantity	Price	No.	Quantity	Price
10554	50 tags	\$0.35	10557	400 tags	\$1.50
10555	100 "	.55	10558	500 "	1.75
10556	200 "	.85	10559	1000 "	3.00

### SEALERS' OFFICE STANDARDS

In some states and cities the laws provide that the Sealer shall maintain two sets of standards, one to be used in testing and sealing, the other to be used in verifying the working standards. These primary standards are at all times kept in a locked case and never taken from the sealer's office except for comparison with the State Standards.

While the maintenance of a duplicate set is the ideal method, this is not absolutely necessary in the smaller cities and towns, as the working standards can be compared from time to time with the State or County Standards. It is advisable, however, that the sealer procure a duplicate set of weights, as these are subject to the most wear and require to be checked frequently.

In order to facilitate the selection of apparatus and the estimation of its cost, a few suggestive outfits are given below.

**No. 10600.** Standard equipment for a State, County, or large City.

Apparatus	No.	Apparatus	No.
Large balance.....	9570	Set capacity measures.....	9350
Small ".....	9591	" ".....	9351
Set avoirdupois weights.....	9213	" ".....	9970
" Troy weights.....	9280	Capacity measure.....	9981
" metric weights.....	9173	" ".....	9982
" ".....	9261	Standard yard.....	9003
" grain weights.....	9241	" meter.....	9004
Price . . . . .			\$2150.00

**No. 10605.** Same as above, but with the addition of case No. 9675. Price . . . . . \$2300.00

Besides the above, the sealer should have a bench standard of length (see page 71).

A State Sealer should have, besides his standards, some representative sets of working apparatus, illustrating the equipment of a City, County, or Town Sealer.

Standards equipment for a County, City, or Town, where only customary weights and measures are sealed.

Apparatus	No. 10650	No. 10652	No. 10654	No. 10656
Case.....	9675	9675	9675	9675
Large balance.....	9570	9570	9570	9570
Set avoirdupois weights	9420	9300	9420	9419
“ “	9303		9303	9303
Set capacity measures..	9930	9850	9890	9891
“ “	10000	9970	10000	10000
Standard yard .....	9000	9003	9000	9012
Price.....	\$510.00	\$935.00	\$515.00	\$475.00

**No. 10660.** Same as No. 10650, but with the addition of small balance No. 9591. Price . . . . . \$630.00

**No. 10663.** Same as No. 10652, but with the addition of small balance No. 9591. Price . . . . . \$1050.00

**No. 10666.** Same as No. 10654, but with the addition of small balance No. 9591. Price . . . . . \$635.00

**No. 10669.** Same as No. 10656, but with the addition of small balance No. 9591. Price . . . . . \$595.00

Standards equipment for a County, City, or Town, where customary and metric weights and measures are sealed.

Apparatus	No. 10700	No. 10702	No. 10704	No. 10706
Case.....	9675	9675	9675	9675
Large balance.....	9570	9570	9570	9570
Set avoirdupois weights.	9300	9420	9420	9419
“ “		9303	9303	9303
“ metric weights.....	9328	9454	9422	9422
“ “		9332	9332	9332
“ “	9260			
“ capacity measures... 9850		9930	9890	9891
“ “ ... 9851		9932	9895	9895
“ “ ... 9970		10000	10000	10030
Standard meter and yard	9002	9002	9002	9002
Price.....	\$1150.00	\$610.00	\$585.00	\$505.00

### WORKING EQUIPMENT

The following working equipments contain everything required to properly test and seal, all unnecessary apparatus being omitted. The number of fifty pound weights needed will vary according to the size of the scales in the

locality, forty of these being required to properly test a railway track scale. The lighter wagon scales can be tested with five hundred pounds, using the methods described on pages 45 to 47.

**No. 10774.** Working equipment for small towns.

Ten 50 lb. weights	9540	Seal press	10238
Grip handle weights	9419	200 lead seals	10243
Portable balance	9556	500 gummed seals	10531
Brass weights		200 condemning tags	10548
Steel tape	9156	2 certificate books	10501
Liquid measures	9936	Steel stamp 3 letters	10168
Dry measures	10035	“ “ 3 “	10166
Dry measure gauge	10070	“ “ 2 “	10168
Price			\$125.00

**No. 10775.** Working equipment for counties and cities.

Twenty 50 lb. weights	9540	200 condemning tags	10548
Grip handle weights	9419	2 certificate books	10501
Brass weights	9305	Steel stamp 3 letters	10168
Portable balance	9560	“ “ 3 “	10166
Yard standard	9015	“ “ 2 “	10168
Liquid measures	9931	Portable drill	10270
Dry measures	10030	2 lbs. lead wire	10285
Dry measure gauge	10069	Tamping punches	10280
Seal press	10238	Cutting pliers	10385
200 lead seals	10243	Sealer's badge	10096
500 gummed seals	10531	Sealing clamp 3 letters	10135
Price			\$190.00

**No. 10776.** Working equipment for larger cities.

Forty 50 lb. weights	9540	500 condemning tags	10551
Grip handle weight	9429	5 certificate books	10501
Small weights	9399	Rubber stamp	10225
Portable balance	9560	“ “	10220
Yard standard	9015	Glass ink	10230
Liquid measures	9930	Lead pad	10231
Dry measures	10030	Steel stamp 3 letters	10168
Steel tape, 50 ft.	9124	“ “ 3 “	10166
Dry measure gauge	10069	“ “ 2 “	10168
Seal press	10238	Sealing clamp 3 letters	10135
500 lead seals	10243	Sealer's badge	10096
1000 gummed seals	10532	Tool kit	10462
Price			\$290.00

**SEALER'S PORTABLE WORKING EQUIPMENT**

**No. 10777.** This equipment was designed to meet the demand for a light sealing outfit in the smaller cities and towns where the Sealer is not provided with a conveyance, except when testing the larger scales. With the exception of the fifty pound weights, the outfit can be carried by one person and it contains everything necessary for testing the customary store scales, weights and measures. It consists of the following:

Ten fifty pound square iron test weights .....	9540
One portable sealing outfit.....	9550
One each, ten and five pound grip weights in case.....	9552
Price . . . . .	\$150.00

The foregoing equipments are recommended by the State Departments of Massachusetts and New York.

# TOLERANCES FOR COMMERCIAL WEIGHTS AND MEASURES

## DIRECTIONS FOR USING TABLES

(Pages 148-151)

The following tables of tolerances or allowable errors are based upon many years' experience in the practical testing of commercial weights and measures. In some localities, however, the sealer is governed by the local statutes or specifications issued by his State Department, and, for that reason, sufficient space has been left to write in the necessary changes.

Having found the value of a certain weight or measure which is being tested, the sealer should look in the table of allowable errors, find what error is permissible in that particular case, then seal or condemn accordingly.

## LINEAR MEASURES

### WOODEN OR METAL MEASURES

Length	Allowable error	Local allowable error
10 to 5 feet	$\frac{3}{16}$ inch	
5 to 3 "	$\frac{1}{8}$ "	
3 to 1 foot	$\frac{1}{16}$ "	
Less than 1 foot	$\frac{1}{32}$ "	

### TAPES AND CHAINS

(Stretching force between 2 and 15 pounds)

Length	Allowable error	Local allowable error
100 feet	$\frac{1}{8}$ inch	
66 "	$\frac{1}{8}$ "	
50 "	$\frac{3}{32}$ "	
33 "	$\frac{1}{16}$ "	
25 "	$\frac{1}{16}$ "	
10 "	$\frac{1}{16}$ "	
6 "	$\frac{1}{32}$ "	
3 "	$\frac{1}{32}$ "	

**LIQUID CAPACITY MEASURES**

(Does not apply to Apothecaries' or Chemists' graduated glass ware)

Measure	Allowable error	Local allowable error
10 gallons	5 fluid ounces or 9 cu. in.	
5 "	3 " " "	5.4 "
4 "	2 " " "	3.6 "
3 "	2 " " "	3.6 "
2 "	1 " " "	1.8 "
1 "	4 " drams	.9 "
1/2 "	3 " " "	.68 "
1 quart	2 " " "	.45 "
1 pint	1.5 " " "	.34 "
1/2 "	1.0 " " "	.22 "
1 gill	1.0 " " "	.22 "

**DRY CAPACITY MEASURES**

Measure	Allowable error	Local allowable error
1 bushel	25 cubic inches	
1/2 "	15 " "	
1 peck	8 " "	
1/2 "	5 " "	
2 quarts	2.5 " "	
1 quart	1.5 " "	
1 pint	1.0 " "	
1/2 "	.5 " "	
1/4 "	.25 " "	

The following table represents the above tolerances for dry measures as applied with the Gurley Dry Measure Gauge (10069, see page 120). When using this gauge the sum of the depth and diameter of the measure under test should not be greater or less than the amounts indicated in the table.

Measure	Maximum	Minimum
1 bushel	100.2	99.8
1/2 "	90.2	89.8
1 peck	80.2	79.8
1/2 "	70.3	69.7
2 quarts	60.3	59.7
1 quart	50.3	49.7
1 pint	40.4	39.6
1/2 "	30.4	29.6
1/4 "	20.4	19.6

## WEIGHTS

(Manufacturers' Tolerances or the Tolerances on new weights are one-half the values listed)

Weight	Ordinary weights (Ratio 1 = 1)	Counterpoise weights for multiplying lever scales		
		Ratio less than 100 = 1	Ratio 100 = 1 and less than 1000 = 1	Ratio 1000 = 1 and over
50 lb.	100 grains	60 grains	40 grains	20 grains
25 "	60 "	36 "	24 "	12 "
20 "	60 "	36 "	24 "	12 "
15 "	40 "	24 "	16 "	8 "
10 "	40 "	24 "	16 "	8 "
8 "	30 "	18 "	12 "	6 "
5 "	30 "	18 "	12 "	6 "
4 "	20 "	12 "	8 "	4 "
3 "	20 "	12 "	8 "	4 "
2 "	15 "	9 "	6 "	3 "
1 "	10 "	6 "	4 "	2 "
10 oz.	10 "	6 "	4 "	2 "
8 "	5 "	3 "	2 "	1 "
5 "	5 "	3 "	2 "	1 "
4 "	5 "	3 "	2 "	1 "
2 "	3 "	1.8 "	1.2 "	.6 "
1 "	2 "	1.2 "	.8 "	.4 "
$\frac{1}{2}$ "	2 "	1.2 "	.8 "	.4 "
$\frac{1}{4}$ "	1 "	.6 "	.4 "	.2 "
$\frac{1}{8}$ "	.5 "	.3 "	.2 "	.1 "
$\frac{1}{16}$ "	.5 "	.3 "	.2 "	.1 "
$\frac{1}{32}$ "	.5 "	.3 "	.2 "	.1 "
$\frac{1}{64}$ "	.2 "	.12 "	.08 "	.04 "
Ratio of tolerances	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$

**TROY, BULLION AND APOTHECARIES' PRESCRIPTION WEIGHTS**

Weight	Allowable error	Local allowable error
500 oz.	7 grains	
300 "	6 "	
200 "	4 "	
100 "	3 "	
50 "	2 "	
40 "	2 "	
30 "	1.5 "	
20 "	1.5 "	
12 "	1.0 "	
10 "	1.0 "	
6 "	.5 "	
5 "	.5 "	
4 "	.5 "	
3 "	.4 "	
2 "	.3 "	
1 "	.2 "	
10 dwt.	.2 "	
4 drams	.2 "	
5 dwt.	.1 "	
2 drams	.1 "	
1 dram	.05 "	
2 dwt.	.05 "	
2 scruples	.05 "	
$\frac{1}{2}$ dram	.05 "	
1 dwt.	.05 "	
1 scruple	.05 "	
10 grains	.03 "	
6 "	.03 "	
5 "	.02 "	
4 "	.02 "	
3 "	.02 "	
2 "	.01 "	
1 "	.01 "	
$\frac{1}{2}$ "	.01 "	
$\frac{1}{4}$ "	.01 "	

**GENERAL REQUIREMENTS FOR WEIGHTS  
FROM CIRCULAR OF THE NATIONAL BUREAU OF STANDARDS**

**Standard Tests.** Weights conforming to the requirements given below will be accepted for regular test and certification.

(1) Weights must be composed of material that is not readily oxidized or otherwise affected by the air or else must be protected by a suitable coating of such material. (Brass or bronze oxidize too rapidly to be used without surface protection.) (2) All but the small weights must be composed of material at least as hard as brass. Weights below 2 grams or 30 grains may be composed of aluminum or metals of similar hardness. (3) Weights provided with a cavity for making adjustments, closed with a plug or removable handle, must have but one cavity and it must be small in proportion to the weight. (Such weights as metal shells filled with lead will be rejected.) (4) There must be no hole or aperture in the bottom of weights of any form, or in the sides of weights having a cylindrical body. (5) Weights must be regular in shape and simple in design. (6) The nominal values of the weights must be plainly engraved, stamped, or otherwise permanently marked upon them, except in weights so small as to render this impracticable. (This requirement may be waived in the case of primary standards of mass (Class M) or in old weights sent to be retested.) (7) The letters or figures must be shallow. (8) With the exception of the large cast iron weights (Class C, 25 lbs. and over only) all metal surfaces must be smooth and sufficiently well polished to readily show scratches or other injuries. The cast iron weights must not show deep pits or sharp projections. (9) They must be adjusted at least within the limits of error of Class C.

Weights not conforming to the general requirements will not be tested except for special reasons. Their corrections will then be determined to the degree of accuracy warranted by their condition and structure. They will be handled as an "extra test" and the report will con-

tain a statement that the weights do not conform to the requirements of the Bureau.

**TOLERANCES**

Avoirdupois weights	Classes A and B	Class C	Class T
50 lbs.	2 grains	10 grains	50 grains
25 "	1.2 "	6 "	30 "
20 "	1.2 "	6 "	30 "
15 "	.8 "	4 "	20 "
10 "	.8 "	4 "	20 "
8 "	.6 "	3 "	15 "
5 "	.6 "	3 "	15 "
4 "	.4 "	2 "	10 "
3 "	.4 "	2 "	10 "
2 "	.3 "	1.5 "	7.5 "
1 "	.2 "	1.0 "	5 "
10 oz.	.2 "	1.0 "	5 "
8 "	.1 "	.5 "	2.5 "
5 "	.1 "	.5 "	2.5 "
4 "	.1 "	.5 "	2.5 "
2 "	.05 "	.3 "	1.5 "
1 "	.04 "	.2 "	1.0 "
1/2 "	.04 "	.2 "	1.0 "
1/4 "	.02 "	.1 "	.5 "
1/8 "	.01 "	.05 "	.25 "
1/16 "	.01 "	.05 "	.25 "
1/32 "	.01 "	.05 "	.25 "
1/64 "	.004 "	.02 "	.1 "

**Classes M & S**

(These values are tentative and will probably be slightly modified)

Denomination	Tolerance	Denomination	Tolerance
20 kilograms	200 milligrams	200 milligrams	.05 milligrams
10 "	100 "	100 "	.05 "
5 "	50 "	50 "	.03 "
2 "	20 "	20 "	.03 "
1 "	10 "	10 "	.03 "
500 grams	5 "	5 "	.02 "
200 "	2 "	2 "	.02 "
100 "	1 "	1 "	.02 "
50 "	.5 "	.5 "	.02 "
20 "	.2 "	.2 "	.02 "
10 "	.2 "	.1 "	.02 "
5 "	.1 "	Σ5 grams	.10 "
2 "	.1 "	Σ500 milligrams	.05 "
1 "	.1 "	Σ50 "	.03 "
500 milligrams	.05 "	Σ5 "	.03 "

## TABLES OF EQUIVALENTS

On pages 154 to 164 are given tables showing the progressive building up of the weights and measures and then tables of equivalents arranged alphabetically. In these latter tables the equivalent of a unit of each measure is found. Long conversion tables have been omitted on purpose, as it is a matter of the simplest multiplication to find the value of a multiple of the unit. Also the equivalents are given in the corresponding units, for instance, the equivalent of one kilogram is given in pounds and not in ounces, pennyweights, etc., these latter being easily found by consulting the tables first given.

Often the Sealer wishes to know only the approximate equivalent, and in that case the values given in the last column may be consulted.

Those who desire more complete tables of equivalents and most excellent conversion tables should procure a copy of Hering's "Conversion Tables" which we can furnish for \$2.00 per copy.

## THE METRIC SYSTEM

As this system has been adopted or legalized by practically every civilized nation, the sealer of weights and measures should become acquainted with it. The simplicity of the system is due to the following properties: (1) it is decimal, (2) there are only three units, (3) these units are related to one another in the simplest possible manner, (4) the same seven prefixes are used for the sub-multiples and multiples of all the three units.

The fundamental unit is the unit of length, the *meter*.

The unit of mass or weight is the *gram*, which equals the weight of one cubic centimeter (centimeter =  $\frac{1}{100}$  meter) of water.

The unit of capacity is the *liter*, which equals  $\frac{1}{1000}$  of a cubic meter or 1000 cubic centimeters.

The prefixes used are the following:

Milli—, which means	$\frac{1}{1000}$
Centi—, “	$\frac{1}{100}$
Deci—, “	$\frac{1}{10}$
Deka—, “	10
Hecto—, “	100
Kilo—, “	1000
Myria—, “	10000

The simplicity of the system may be understood from this problem:

What quantity of water by measure and weight will it take to fill a tank  $2.5 \times 2.6 \times 1.25$  meters?

Solution:  $2.5 \times 2.6 \times 1.25 = 8.125$  cubic meters. Therefore the tank will hold 8125 liters or 8125 kilograms or 8.125 metric tons of water.

Anyone who will work a similar problem, using yards, gallons, pounds, and tons, will be convinced of the simplicity of the metric system.

### LENGTH

10 millimeters (mm.)	= 1 centimeter (cm.)
10 cm.	= 1 decimeter (dm.)
10 dm.	= 1 meter (m.)
10 m.	= 1 dekameter (dkm.)
10 dkm.	= 1 hectometer (hm.)
10 hm.	= 1 kilometer (km.)

### SURFACE

The surface measures are the squares of the linear measures, but for land measures 100 square meters are called an “*ar*”.

100 ars (a.)	= 1 hectare (ha.)
--------------	-------------------

### CAPACITY

10 milliliters (ml.)	= 1 centiliter (cl.)
10 cl.	= 1 deciliter (dl.)
10 dl.	= 1 liter (l.)
10 l.	= 1 dekaliter (dkl.)
10 dkl.	= 1 hectoliter (hl.)
10 hl.	= 1 kiloliter (kl.)

**WEIGHT**

10 milligrams (mg.)	= 1 centigram (cg.)
10 cg.	= 1 decigram (dg.)
10 dg.	= 1 gram (g.)
10 g.	= 1 dekagram (dkg.)
10 dkg.	= 1 hectogram (hg.)
10 hg.	= 1 kilogram (kg.)
10 kg.	= 1 myriagram (mrg.)
10 mrg.	= 1 metric quintal (q.)
10 q.	= 1 metric ton (t.)

**UNITED STATES AND ENGLISH LINEAR MEASURE**

12 inches (in.)	= 1 foot (ft.)
3 ft.	= 1 yard (yd.) = 36 in.
5½ yd.	= 1 rod (rd.) = 16½ ft.
320 rd.	= 1 mile (mi.) = 1760 yd. = 5280 ft.

**SURVEYOR'S MEASURE**

625 square links (sq. li.)	= 1 square rod (sq. rd.)
16 sq. rd.	= 1 square chain (sq. ch.)
10 sq. ch.	= 1 acre (a.)
640 a.	= 1 square mile (sq. mi.)
36 sq. mi. (6 mi. square)	= 1 township (tp.) = 23040 a.

**CHAIN MEASURE**

(Surveyor's or Gunter's Chain)

7.92 inches	= 1 link (li.)
100 li.	= 1 chain (ch) = 66 ft.
80 ch.	= 1 mile (mi.)

The engineer's chain is 100 feet long and consists of 100 links.

**SQUARE MEASURE**

144 square inches (sq. in.)	= 1 square foot (sq. ft.)
9 sq. ft.	= 1 square yard (sq. yd.)
30¼ sq. yd.	= 1 square rod (sq. rd.)
160 sq. rd.	= 1 acre (a.)

**UNITED STATES AND ENGLISH LIQUID MEASURE**

4 gills (gi.)	= 1 pint (pt.)
2 pt.	= 1 quart (qt.) = 8 gi.
4 qt.	= 1 gallon (gal.) = 8 pt. = 32 gi.
31½ gal.	= 1 barrel (bbl.) = 126 qt.
2 bbls.	= 1 hogshead (hhd.) = 63 gal. = 252 qt.

**CUBIC MEASURE**

1728 cubic inches (cu. in.)	= 1 cubic foot (cu. ft.)
27 cu. ft.	= 1 cubic yard (cu. yd.)

**U. S. DRY MEASURE**

2	pints (pt.)	= 1 quart (qt.)
8	qt.	= 1 peck (pk.) = 16 pt.
4	pk.	= 1 bushel (bu.) = 32 qt. = 64 pt.

**APOTHECARIES' FLUID MEASURE**

60	minims (m.)	= 1 fluid dram = (fl. dr.)
8	fl. dr.	= 1 fluid ounce (fl. oz.) = 480 m.
16	fl. oz.	= 1 pint (O.) = 128 fl. dr. = 7680 m.
8	O.	= 1 gallon (cong.) = 128 fl. oz. = 1024 fl. dr.

**AVOIRDUPOIS WEIGHT**

27 $\frac{1}{2}$	grains (gr.)	= 1 dram (dr.)
16 dr.		= 1 ounce (oz.) = 437 $\frac{1}{2}$ gr.
16 oz.		= 1 pound (lb.) = 256 dr. = 7000 gr.
100 lb.		= 1 hundred weight (cwt.) = 1600 oz.
20 cwt.		= 1 ton (t.) = 2000 lb.
		(In long measure.)
112 lb.		= 1 cwt.
20 cwt.		= 1 long ton (t.) = 2240 lb.

**TROY WEIGHT**

24	grains (gr.)	= 1 pennyweight (dwt.)
20 dwt.		= 1 ounce (oz.) = 480 grains
12 oz.		= 1 pound (lb.) = 240 dwt. = 5760 gr.

**APOTHECARIES' WEIGHT**

20	grains (gr.)	= 1 scruple (℥)
3 ℥		= 1 dram (ʒ) = 60 gr.
8 ʒ		= 1 ounce (℥) = 24 ℥ = 480 gr.
12 ʒ		= 1 pound (lb) = 96 ʒ = 288 ℥ = 5760 gr.

Lengths	Abbreviations	Equivalents	Approximate Equivalents
1 barleycorn	bc.	8.4667 $\frac{1}{3}$	millimeters inch 8.5
1 bolt	b.	36.5760 40.	meters yards 36.5
1 centimeter	cm.	.3937	inch .4
1 chain	ch.	20.117	meters 20.1
Gunther's		66.	feet
1 chain	ch.	30.480	meters 30.5
engineer's		100.	feet
1 fathom	f.	1.8288	meters %
(U. S.)		6.	feet
1 fathom	f.	1.853	meters 1 $\frac{1}{2}$
(British)		6.080	feet
1 foot	ft.	30.4801	centimeters 30.5
(U. S.)		1.0000029	ft. (British) 1.
1 foot	ft.	30.4800	centimeters 30.5
(British)		.9999971	ft. (U. S.) 1.

Lengths	Abbreviations	Equivalents	Approximate Equivalents
1 furlong	fur.	201.17 660.	meters feet 200.
1 inch	in.	2.5400 1000.	centimeters mils. 2.5
1 kilometer	km.	3280.83 .6214	ft. mile (statute or land) 3300. $2\frac{3}{4}$
1 knot	k.	1.8533	kilometers $1\frac{1}{4}$
or nautical mile		1.1515	miles $8\frac{1}{8}$
1 league (U. S.)	l	4.8281 3.	kilometers miles $4\frac{7}{8}$
1 link Surveyor's	li.	20.117	centimeters 20.1
1 link engineer's	li.	30.480	centimeters $30\frac{1}{2}$
1 meter	m.	39.370000 39.370113 1.0936	in. (U. S.) in. (British) yards 40 40 1.1
1 micro-millimeter	$\mu\mu$ .	.00003937	mil.
1 micron	$\mu$ .	.000001 .03937	millimeter mil.
1 mil		.001 .0254 .001	millimeter millimeter inch
1 mile (statute or land)	ml.	1609.35 1.6094 .8684	meters kilometers knot 1600 $1\frac{2}{3}$ $\frac{1}{8}$
1 mile geographical international	ml.	7422.	meters 7400
1 mile nautical	ml.	4.6118 1	miles knot $4\frac{2}{3}$
1 mile nautical international	ml.	1852	meters
1 millimeter	mm.	1.1508 .03937 39.37	miles inch mils. $1\frac{1}{4}$ $\frac{1}{25}$ 40
1 perch, pole or rod	p., r.	5.0292	meters 5
1 vara	v.	.8476 33.372	meter inches $7\frac{7}{8}$ $33\frac{1}{3}$
1 yard (U. S.)	yd.	91.4402 .9144	centimeters meter 90 .9
1 yard (British)	yd.	1.0000029 91.4399 .9144 .9999971	yd. (British) centimeters meters yd. (U. S.) 1 90 1

Area or Surface Measure	Abbreviations	Equivalents		Approximate Equivalents
1 acre	a.	40.4687 4046.27 .4047	ares sq. meters hectare	40 4000 .4
1 are or ar	a.	100. 1076.387 .0247	sq. meters sq. ft. acre	1100
1 circular mil.	cm.	.0006452 circular millimeter		
1 circular millimeter cmm.		.0005067 1550.00	sq. millimeter circular mils.	1500
1 square centimeter $\overline{\text{cm}}^2$		.7854 .1550	sq. millimeter sq. in.	$\frac{3}{4}$ $\frac{2}{13}$
1 square chain (surveyors')	sq. ch.	404.687 4.0469	sq. meters ares	400 4
1 square decimeter $\overline{\text{dm}}^2$		15.500 .10764	sq. in. sq. ft.	
1 square foot (U. S.) sq. ft.		929.034 1.0000057	sq. centimeters sq. ft.	925
1 sq. foot (British) sq. ft.		929.029 .9999942	(British) sq. centimeters sq. ft. (U. S.)	1 925 1
1 hectare	ha.	2.4710 107638.7	acres sq. ft.	2.5
1 square inch	sq. in.	6.4516	sq. centimeters	6.5
1 square kilometer	$\overline{\text{km}}^2$	247.104 .3861	acres sq. mi's	250 $\frac{1}{8}$
1 sq. meter	$\overline{\text{m}}^2$	1.19599 10.7639	sq. yd. sq. ft.	$1\frac{1}{8}$ $10\frac{1}{4}$
1 square mile	sq. ml.	25900. 259. 2.59	ares hectares sq. kilometers	260 $2\frac{1}{2}$
1 sq. mil.	$\overline{\text{mil}}^2$	.0006452	sq. millimeters	
1 sq. millimeter	$\overline{\text{mm}}^2$	.00155 1550.	sq. inches sq. inches sq. mils.	
1 sq. myriameter		38.6101	sq. miles	$38\frac{2}{3}$
1 sq. yard	sq. yd.	.83613 93.21 .9321	sq. meters sq. kilometers myriameters	$\frac{7}{8}$ 90 1
1 township		36.	sq. miles	

Volume	Abbreviations	Equivalents	Approximate Equivalents
1 board foot	b. f.	144 cu. in., viz. 1 sq. ft. sur- face and 1 in. thick	
1 bushel (U. S.)	bu.	35239.28 cubic centi- meters 35.2393 liters 35239 hectoliters 2150.420 cubic inches .96897 bu. (British)	35000 35 1/3 1
1 bushel (British)	bu.	36367.7048 cubic centi- meters 36.3677 liters 36368 hectoliters 2219.28 cubic inches 1.032 bu. (U. S.)	36000 36 1/3 1/3 2200
1 cord	c.	4 x 4 x 8 3.62458 ft. steres or cubic meters	3 2/3
1 cu. centimeter	cc. or cm <sup>3</sup>	.0610234 cubic inches	
1 cu. decimeter	dm <sup>3</sup>	61.0234 cubic inches .0353 cubic foot	60
1 cubic foot	ft. <sup>3</sup> or cu. ft.	28317.1 liter 28.317 cu. centi- meters 28317 liters 29.922 hectolitor 24.916 liquid qt. (U. S.) quarts (British)	28000 28 1/3 1/4 25
1 cubic inch	cu. in.	25.714 dry quarts 16.387 cubic centi- meters	25 3/4 16 1/3
1 cu. meter	cu. m. or m <sup>3</sup>	1 stere = 10 heccoliters 35.314 cubic feet 28.3774 bu. (U. S.) 27.4969 bu. (British) 1.30794 cu. yards 264.170 ga lons (U. S.) 219.975 gallons (British)	35 1/3 28 1/3 27.5 1 1/4 265 220
1 cubic yard	cu. yd.	.764559 stere or cu. meter	3/4

Volume	Abbreviations	Equivalents		Approximate Equivalents
1 cubic yard	cu. yd.	764.559	liters	760
		201.974	gallons (U. S.)	200
		168.184	gallons (British)	170
		21.6962	bu. (U. S.)	22
		21.023	bu. (British)	21
1 dram (U. S.) fluid	fl. dr.	3.6967	milliliters or cubic centi- meters	$3\frac{3}{8}$
		.22559	cu. in.	$\frac{1}{4}$
1 dram (British) fluid	fl. dr.	3.5515	milliliters or cubic centimeters	$3\frac{1}{2}$
		.2167	cu. in.	$\frac{1}{8}$
1 gallon (U. S.)	gal.	3.78543	liters	$3\frac{3}{4}$
		.8327	gallon (British)	$\frac{7}{8}$
		231 cu. in =	8.323 lbs. water	
1 gallon (British)	gal.	4.54 96	liters	$4\frac{1}{2}$
		1.2009	gal. (U. S.)	$1\frac{1}{8}$
		277.410	cu. in. = 10 lbs. water	270
1 gill (U. S.)	gi.	118.295	cu. centimeters	120
		.1183	liter	1
		7.2188	cu. in.	$7\frac{1}{8}$
1 gill (British)	gi.	142.0614	cu. centimeter	
		.14206	liter	$\frac{5}{8}$
		8.6691	cu. in.	$8\frac{3}{8}$
1 hectoliter	hl.	26.417	gallons (U. S.)	$26\frac{3}{4}$
		21.997	gal. (British)	22
		2.8377	bu. (U. S.)	$2\frac{7}{8}$
		2.7497	bu. (British)	$2\frac{1}{4}$
1 hogshead (U. S.)	hhd.	2.3848	hectoliters	$2\frac{1}{8}$
1 hogshead (British)	hhd.	2.86396	hectoliters	$2\frac{7}{8}$
1 liter	l.	61.0234	cu. in.	61
		1.05668	quarts (U. S. liquid)	1
		.8799	quarts (British)	$\frac{3}{4}$
		.9081	quart (U. S. dry)	.9
1 milliliter	ml.	1.	cu. centimeter	
1 minim (U. S.)	m.	61.612	cu. millimeters	$61\frac{3}{8}$
		.0616	milliliters	$\frac{3}{80}$
1 minim (British)	m.	59.1922	cu. millimeters	59
		.05919	milliliters	

Volume	Abbreviations	Equivalents	Approximate Equivalents
1 ounce (U. S.) fluid	fl. oz.	29.5737 1.8047 23.4123	cu. centimeters 29½ cu. in. 1¼ cu. centimeters 28¾
1 ounce (British) fluid	fl. oz.	1.7338 8.80982 2.327 .96897	cu. in. 1¾ liters 8¾ gallons (U. S.) 2⅓ peck (British) 1
1 peck (U. S.)	pk.	537.605 .3111 9.09193 1.032	cu. in. 530 cu. ft. ⅓ liters 9.1 pecks (U. S.) 1
1 peck (British)	pk.	554.82 .3211	cu. in. 550 cu. ft. ⅓
1 perch	p.	16½ x 1½ x 1 ft. (masonry)	
1 pint (U. S.) liquid	pt.	.7 stere or cu. meter .4732	liter 1½
		4.7318 28.875 .8594	deciliters 4¾ cu. in. 28⅞ pint (U. S. dry) ⅞
1 pint (U. S.) dry	pt.	.8327 .5506	pint (British) ⅞ liter 1½
		33.600 1.1637 .96897	cu. in. 33 ⅓ pints (U. S. liquid) 1½ pints (British) 1
1 pint (British)	pt.	.5682 34.6762 1.2009	liter ¾ cu. in. 34⅓ pints (U. S. liquid) 1½
1 quart (U. S.) liquid	qt.	.94636	liter 1
		57.750 .8594	cu. in. = 57¾ 2.086 lbs. water quart (U. S. dry) ⅞
1 quart (U. S.) dry	qt.	.8327 1.10123	quart (British) ⅞ liters 1.1

Volume	Abbreviations	Equivalents	Approximate
1 quart (U. S.) dry	qt.	67.2006 cu. in.	Equivalents 67½
		1.1637 quarts (U. S. liquid)	1½
		.96897 quarts (British)	1
1 quart (British)	qt.	1.1365 liters	1⅞
		69.3525 cu. in.	69⅓
		1.2009 quarts (U. S. liquid)	1½
1 stere	s.	1. cubic meter	

Weights or Masses	Abbreviations	Equivalents	Approximate
1 carat	c.	3.1714 grains	Equivalents 3⅞
		205.500 milligrams	
1 centigram	cg.	.15432 grain	⅔
1 decigram	dg.	1.54324 grain	1½
1 dekagram	dkg.	.35276 oz. (av.)	⅓
1 drachm (ap.)	3	3.887934 grams	3⅞
		2.19429 drams (av.)	2⅞
1 dram (av.)	dr.	1.77185 grams	1¾
		.45573 drams (ap.)	⅕
1 grain	gr.	64.7989 milligram	64¾
1 gram	g.	15.4323564 grains	15⅞
		.035274 oz. (av.)	
		.032151 oz. (Troy)	
1 hundredweight (long)	cwt.	50.8024 kilograms	50½
1 hundredweight (short)	cwt.	45.35924 kilograms	45⅓
1 kilogram	kg.	2.20462 pounds (av.)	2⅞
		2.67923 pounds (Troy)	2⅞
1 metric ton	t.	2204.62 pounds (av.)	2200
		1.1023 net tons	1.1
1 milligram	mg.	.015423 grain	
1 ounce (apothecaries')	℥	31.1035 grams	31.1
		1.09714 oz. (av.)	1.1
		1. oz. (Troy)	
1 ounce (avoirdupois)	oz.	28.3495 grams	28⅓
		.911458 oz. (Troy)	.9

Weights or Masses	Abbreviations	Equivalents	Approximate Equivalents
1 ounce (Troy)	oz.	31.1035 grams	31.1
		1.09714 oz. (av.)	1.1
		1 oz. (ap.)	
1 pennyweight	dwt.	1.55517 grams	1½
1 pound (av.)	lb.	453.592428 grams	450.
		.45359 kilogram	$\frac{9}{20}$
		1.21528 lb. (Troy)	1½
		14.5833 oz. (Troy)	100%
		7000 grains	
1 pound (Troy)	lb.	373.242 grams	373¼
		.822857 pound (av.)	$\frac{5}{6}$
		5760 grains	
1 quarter	qr.	11.3368 kilograms	11⅓
		25 pounds (av.)	
1 scruple	℥	1.295978 grams	1⅓
1 ton (net or short)	tn. or t.	907.185 kilograms	900
		.907185 metric ton	.9
1 ton long or gross	tn. or t.	1016.05 kilograms	1000
		1.016 metric tons	
1 tonne or tonneau	t.	1 metric ton	

### APPROXIMATE AVOIRDUPOIS EQUIVALENTS

The following table will be found useful for testing scales graduated in the metric system, where the sealer is not provided with metric weights. It is accurate to the nearest 1/16 oz.

1	Kilogram	=	2 lbs., 3¼ oz. avoirdupois.
2	"	=	4 " 6½ "
5	"	=	11 " 3⅞ "
10	"	=	22 " 3¼ "
20	"	=	44 " 1½ "
25	"	=	55 " 1⅞ "

## DIRECTIONS FOR USING TABLES

Pages 165-191

To determine the volume of any cylindrical measure, find its diameter and depth. Find the column headed with the number corresponding with the diameter and then in this column find the number opposite a row corresponding with the depth. This number indicates the cubical contents.

Illustration: Suppose a measure has a diameter of  $8\frac{1}{8}$  inches and a depth of  $10\frac{3}{8}$  inches. Find the column (see page 179) headed  $8\frac{1}{8}$ , then pass down the column till opposite  $10\frac{3}{8}$ , and there is found 537.93. This is the contents of the measure, namely 537.93 cubic inches. Or, if the measurement had been made in centimeters, the contents would be cubic centimeters. If the measurement had been made in decimeters, the contents would be 537.93 cubic decimeters or liters.

The sealer will soon become familiar with the cubical contents of the customary measures. They are found in the tables on page 189.

Having determined the contents, the allowable error or tolerance should be looked up on pages 148 to 151 and the measure sealed or condemned accordingly.

Height	DIAMETER							
	2	2 $\frac{1}{8}$	2 $\frac{1}{4}$	2 $\frac{3}{8}$	2 $\frac{1}{2}$	2 $\frac{5}{8}$	2 $\frac{3}{4}$	2 $\frac{7}{8}$
2 $\frac{1}{2}$	7.85	8.87	9.94	11.08	12.27	13.53	14.85	16.23
2 $\frac{5}{8}$	8.25	9.31	10.44	11.62	12.89	14.20	15.59	17.04
2 $\frac{3}{4}$	8.64	9.75	10.93	12.18	13.60	14.88	16.33	17.85
2 $\frac{7}{8}$	9.03	10.20	11.43	12.73	14.11	15.56	17.08	18.66
3	9.42	10.64	11.93	13.29	14.73	16.24	17.82	19.48
3 $\frac{1}{8}$	9.82	11.08	12.42	13.84	15.34	16.91	18.56	20.29
3 $\frac{1}{4}$	10.21	11.53	12.92	14.40	15.95	17.59	19.30	21.10
3 $\frac{3}{8}$	10.60	11.97	13.42	14.95	16.57	18.27	20.05	21.91
3 $\frac{1}{2}$	10.995	12.41	13.92	15.51	17.18	18.94	20.79	22.72
3 $\frac{5}{8}$	11.39	12.86	14.41	16.06	17.79	19.62	21.53	23.53
3 $\frac{3}{4}$	11.78	13.30	14.91	16.61	18.41	20.29	22.27	24.34
3 $\frac{7}{8}$	12.17	13.74	15.40	17.17	19.02	20.97	23.02	25.16
4	12.57	14.19	15.90	17.72	19.64	21.65	23.76	25.97
4 $\frac{1}{8}$	12.96	14.63	16.40	18.27	20.25	22.32	24.50	26.78
4 $\frac{1}{4}$	13.35	15.07	16.90	18.83	20.86	23.00	25.24	27.59
4 $\frac{3}{8}$	13.74	15.51	17.40	19.38	21.48	23.68	25.99	28.40
4 $\frac{1}{2}$	14.14	15.96	17.89	19.94	22.09	24.35	26.73	29.22
4 $\frac{5}{8}$	14.53	16.49	18.39	20.49	22.70	25.03	27.47	30.03
4 $\frac{3}{4}$	14.92	16.85	18.89	21.04	23.32	25.71	28.21	30.84
4 $\frac{7}{8}$	15.32	17.29	19.38	21.60	23.93	26.38	28.96	31.65
5	15.71	17.73	19.88	22.15	24.54	27.06	29.70	32.46
5 $\frac{1}{8}$	16.10	18.18	20.38	22.70	25.16	27.74	30.44	33.27
5 $\frac{1}{4}$	16.49	18.62	20.87	23.26	25.77	28.41	31.18	34.08
5 $\frac{3}{8}$	16.89	19.06	21.37	23.81	26.38	29.09	31.92	34.89
5 $\frac{1}{2}$	17.28	19.51	21.87	24.37	27.00	29.76	32.67	35.70
5 $\frac{5}{8}$	17.67	19.95	22.37	24.92	27.61	30.44	33.41	36.52
5 $\frac{3}{4}$	18.06	20.39	22.86	25.47	28.23	31.12	34.15	37.33
5 $\frac{7}{8}$	18.46	20.84	23.36	26.03	28.84	31.79	34.89	38.14
6	18.85	21.28	23.86	26.58	29.45	32.47	35.64	38.95
6 $\frac{1}{8}$	19.24	21.72	24.35	27.13	30.07	33.15	36.38	39.76
6 $\frac{1}{4}$	19.64	22.17	24.95	27.69	30.68	33.82	37.12	40.57
6 $\frac{3}{8}$	20.03	22.61	25.45	28.24	31.29	34.50	37.86	41.39
6 $\frac{1}{2}$	20.42	23.05	25.94	28.80	31.91	35.18	38.60	42.20
6 $\frac{5}{8}$	20.81	23.50	26.44	29.35	32.52	35.85	39.35	43.01
6 $\frac{3}{4}$	21.21	23.94	26.94	29.90	33.13	36.53	40.09	43.82
6 $\frac{7}{8}$	21.60	24.38	27.34	30.46	33.75	37.21	40.83	44.63
7	21.99	24.83	27.83	31.01	34.36	37.88	41.58	45.44
7 $\frac{1}{8}$	22.38	25.27	28.33	31.56	34.97	38.56	42.32	46.25
7 $\frac{1}{4}$	22.78	25.71	28.83	32.12	35.59	39.24	43.06	47.07

Height	DIAMETER							
	2	2 $\frac{1}{8}$	2 $\frac{1}{4}$	2 $\frac{3}{8}$	2 $\frac{1}{2}$	2 $\frac{5}{8}$	2 $\frac{3}{4}$	2 $\frac{7}{8}$
7 $\frac{3}{8}$	23.17	26.16	29.32	32.67	36.20	39.91	43.80	47.88
7 $\frac{1}{2}$	23.56	26.60	29.82	33.23	36.82	40.59	44.55	48.69
7 $\frac{5}{8}$	23.95	27.04	30.32	33.79	37.43	41.26	45.29	49.50
7 $\frac{3}{4}$	24.35	27.49	30.81	34.33	38.04	41.94	46.03	50.31
7 $\frac{7}{8}$	24.74	27.93	31.31	34.89	38.66	42.62	46.77	51.12
8	25.13	28.37	31.81	35.44	39.27	43.29	47.52	51.93
8 $\frac{1}{8}$	25.52	28.82	32.31	35.99	39.88	43.97	48.26	52.75
8 $\frac{1}{4}$	25.92	29.26	32.80	36.55	40.50	44.65	49.00	53.56
8 $\frac{3}{8}$	26.31	29.70	33.30	37.10	41.11	45.32	49.74	54.37
8 $\frac{1}{2}$	26.70	30.15	33.80	37.66	41.72	46.00	50.49	55.18
8 $\frac{5}{8}$	27.10	30.59	34.29	38.21	42.34	46.68	51.23	55.99
8 $\frac{3}{4}$	27.49	31.03	34.79	38.76	42.95	47.35	51.97	56.80
8 $\frac{7}{8}$	27.88	31.48	35.29	39.32	43.57	48.03	52.71	57.61
9	28.27	31.92	35.78	39.87	44.18	48.71	53.46	58.43
9 $\frac{1}{8}$	28.67	32.36	36.28	40.42	44.79	49.38	54.20	59.24
9 $\frac{1}{4}$	29.06	32.81	36.78	40.98	45.41	50.06	54.94	60.05
9 $\frac{3}{8}$	29.45	33.25	37.28	41.53	46.02	50.74	55.68	60.86
9 $\frac{1}{2}$	29.85	33.69	37.77	42.09	46.63	51.41	56.43	61.67
9 $\frac{5}{8}$	30.24	34.14	38.27	42.64	47.25	52.09	57.17	62.48
9 $\frac{3}{4}$	30.63	34.58	38.77	43.19	47.86	52.77	57.91	63.30
9 $\frac{7}{8}$	31.02	35.02	39.26	43.75	48.47	53.44	58.65	64.11
10	31.42	35.465	39.76	44.30	49.09	54.12	59.40	64.92
10 $\frac{1}{8}$	31.81	35.91	40.26	44.85	49.70	54.79	60.14	65.73
10 $\frac{1}{4}$	32.20	36.35	40.76	45.41	50.32	55.47	60.88	66.54
10 $\frac{3}{8}$	32.59	36.79	41.25	45.96	50.93	56.15	61.62	67.35
10 $\frac{1}{2}$	32.99	37.24	41.75	46.52	51.54	56.82	62.36	68.16
10 $\frac{5}{8}$	33.38	37.68	42.25	47.07	52.16	57.50	63.11	68.98
10 $\frac{3}{4}$	33.77	38.12	42.74	47.62	52.77	58.18	63.85	69.79
10 $\frac{7}{8}$	34.16	38.57	43.24	48.18	53.38	58.85	64.59	70.60
11	34.56	29.01	43.74	48.73	54.00	59.53	65.33	71.41
11 $\frac{1}{8}$	34.95	39.45	44.23	49.28	54.61	60.21	66.08	72.22
11 $\frac{1}{4}$	35.34	39.90	44.73	49.83	55.22	60.88	66.82	73.03
11 $\frac{3}{8}$	35.74	40.34	45.23	50.39	55.84	61.56	67.56	73.84
11 $\frac{1}{2}$	36.13	40.78	45.73	50.95	56.45	62.24	68.30	74.66
11 $\frac{5}{8}$	36.52	41.23	46.22	51.50	57.06	62.91	69.05	75.47
11 $\frac{3}{4}$	36.91	41.67	46.72	52.05	56.68	63.59	69.79	76.28
11 $\frac{7}{8}$	37.31	42.11	47.22	52.60	58.29	64.27	70.53	77.09
12	37.70	42.56	47.71	53.16	58.91	64.94	71.27	77.90

Height	DIAMETER							
	3	3 $\frac{1}{8}$	3 $\frac{1}{4}$	3 $\frac{3}{8}$	3 $\frac{1}{2}$	3 $\frac{5}{8}$	3 $\frac{3}{4}$	3 $\frac{7}{8}$
2 $\frac{1}{2}$	17.67	19.17	20.74	22.37	24.05	25.80	27.61	29.48
2 $\frac{5}{8}$	18.56	20.13	21.78	23.48	25.25	27.09	28.99	30.96
2 $\frac{3}{4}$	19.44	21.09	22.81	24.60	26.46	28.38	30.37	32.43
2 $\frac{7}{8}$	20.32	22.05	23.85	25.72	27.66	29.67	31.75	33.91
3	21.21	23.01	24.89	26.84	28.86	30.96	33.13	35.38
3 $\frac{1}{8}$	22.09	23.97	25.92	27.96	30.07	32.25	34.51	36.85
3 $\frac{1}{4}$	22.97	24.93	26.96	29.07	31.27	33.54	35.89	38.33
3 $\frac{3}{8}$	23.86	25.88	28.00	30.19	32.47	34.83	37.27	39.80
3 $\frac{1}{2}$	24.74	26.84	29.03	31.31	33.67	36.12	38.65	41.28
3 $\frac{5}{8}$	25.62	27.80	30.07	32.43	34.88	37.41	40.03	42.75
3 $\frac{3}{4}$	26.51	28.76	31.11	33.55	36.08	38.70	41.42	44.22
3 $\frac{7}{8}$	27.39	29.72	32.15	34.67	37.28	39.99	42.80	45.70
4	28.28	30.68	33.18	35.78	38.48	41.28	44.18	47.17
4 $\frac{1}{8}$	29.16	31.64	34.22	36.90	39.69	42.57	45.56	48.65
4 $\frac{1}{4}$	30.04	32.60	35.26	38.02	40.89	43.86	46.94	50.12
4 $\frac{3}{8}$	30.93	33.55	36.29	39.14	42.09	45.15	48.32	51.60
4 $\frac{1}{2}$	31.81	34.51	37.33	40.26	43.29	46.44	49.70	53.07
4 $\frac{5}{8}$	32.69	35.47	38.37	41.38	44.50	47.73	51.08	54.53
4 $\frac{3}{4}$	33.58	36.43	39.40	42.49	45.70	49.02	52.46	56.01
4 $\frac{7}{8}$	34.46	37.39	40.44	43.61	46.90	50.31	53.84	57.48
5	35.34	38.35	41.48	44.73	48.11	51.60	55.22	58.97
5 $\frac{1}{8}$	36.23	39.31	42.52	45.85	49.31	52.89	56.60	60.44
5 $\frac{1}{4}$	37.11	40.27	43.55	46.97	50.51	54.18	57.98	61.91
5 $\frac{3}{8}$	37.99	41.23	44.59	48.08	51.71	55.47	59.36	63.39
5 $\frac{1}{2}$	38.88	42.18	45.63	49.20	52.92	56.76	60.75	64.86
5 $\frac{5}{8}$	39.76	43.14	46.66	50.32	54.12	58.05	62.13	66.34
5 $\frac{3}{4}$	40.64	44.10	47.70	51.44	55.32	59.34	63.51	67.81
5 $\frac{7}{8}$	41.53	45.06	48.74	52.56	56.52	60.63	64.89	69.29
6	42.41	46.02	49.77	53.68	57.73	61.92	66.27	70.76
6 $\frac{1}{8}$	43.30	46.98	50.81	54.79	58.93	63.21	67.65	72.23
6 $\frac{1}{4}$	44.18	47.94	51.85	55.91	60.13	64.50	69.03	73.71
6 $\frac{3}{8}$	45.06	48.90	52.89	57.03	61.33	65.79	70.41	75.18
6 $\frac{1}{2}$	45.95	49.85	53.92	58.15	62.54	67.08	71.79	76.66
6 $\frac{5}{8}$	46.83	50.81	54.96	59.27	63.74	68.37	73.17	78.13
6 $\frac{3}{4}$	47.71	51.77	56.00	60.39	64.94	69.66	74.55	79.60
6 $\frac{7}{8}$	48.60	52.73	57.03	61.50	66.15	70.95	75.93	81.08
7	49.48	53.69	58.07	62.62	67.35	72.24	77.31	82.55
7 $\frac{1}{8}$	50.36	54.65	59.11	63.74	68.55	73.53	78.69	84.03
7 $\frac{1}{4}$	51.25	55.61	60.14	64.86	69.75	74.82	80.07	85.50

Height	DIAMETER							
	3	3 $\frac{1}{8}$	3 $\frac{1}{4}$	3 $\frac{3}{8}$	3 $\frac{1}{2}$	3 $\frac{5}{8}$	3 $\frac{3}{4}$	3 $\frac{7}{8}$
7 $\frac{3}{8}$	52.13	56.57	61.18	65.98	70.96	76.11	81.45	86.97
7 $\frac{1}{2}$	53.01	57.52	62.22	67.10	72.16	77.40	82.83	88.45
7 $\frac{5}{8}$	53.90	58.48	63.26	68.22	73.36	78.69	84.22	89.92
7 $\frac{3}{4}$	54.78	59.44	64.29	69.33	74.56	79.98	85.60	91.40
7 $\frac{7}{8}$	55.67	60.40	65.33	70.45	75.77	81.27	86.98	92.87
8	56.55	61.36	66.37	71.57	76.97	82.56	88.36	94.35
8 $\frac{1}{8}$	57.43	62.32	67.40	72.67	78.17	83.85	89.74	95.82
8 $\frac{1}{4}$	58.32	63.28	68.44	73.81	79.37	85.14	91.12	97.29
8 $\frac{3}{8}$	59.20	64.24	69.48	74.93	80.58	86.43	92.50	98.77
8 $\frac{1}{2}$	60.08	65.19	70.51	76.04	81.78	87.72	93.88	100.24
8 $\frac{5}{8}$	60.97	66.15	71.54	77.16	82.98	89.01	95.26	101.72
8 $\frac{3}{4}$	61.85	67.11	72.59	78.28	84.18	90.30	96.64	103.19
8 $\frac{7}{8}$	62.73	68.07	73.63	79.40	85.39	91.59	98.02	104.66
9	63.62	69.03	74.66	80.51	86.59	92.89	99.40	106.14
9 $\frac{1}{8}$	64.50	69.99	75.70	81.63	87.79	94.18	100.78	107.61
9 $\frac{1}{4}$	65.39	70.95	76.74	82.75	89.00	95.47	102.16	109.09
9 $\frac{3}{8}$	66.27	71.91	77.77	83.87	90.20	96.76	103.54	110.56
9 $\frac{1}{2}$	67.15	72.86	78.80	84.99	91.40	98.05	104.92	112.04
9 $\frac{5}{8}$	68.04	73.82	79.84	86.11	92.60	99.34	106.30	113.51
9 $\frac{3}{4}$	68.92	74.78	80.88	87.23	93.81	100.63	107.68	114.98
9 $\frac{7}{8}$	69.70	75.74	81.92	88.35	95.01	101.92	109.07	116.46
10	70.69	76.70	82.96	89.46	96.21	103.21	110.45	117.93
10 $\frac{1}{8}$	71.57	77.66	84.00	90.58	97.41	104.50	111.83	119.41
10 $\frac{1}{4}$	72.45	78.62	85.03	91.70	98.62	105.79	113.21	120.88
10 $\frac{3}{8}$	73.34	79.58	86.07	92.82	99.82	107.08	114.59	122.35
10 $\frac{1}{2}$	74.22	80.53	87.11	93.94	101.02	108.37	115.97	123.83
10 $\frac{5}{8}$	75.10	81.49	88.14	95.06	102.22	109.66	117.35	125.30
10 $\frac{3}{4}$	75.99	82.45	89.18	96.17	103.43	110.95	118.73	126.78
10 $\frac{7}{8}$	76.87	83.41	90.22	97.29	104.63	112.24	120.11	128.25
11	77.75	84.37	91.25	98.41	105.83	113.53	121.49	129.73
11 $\frac{1}{8}$	78.64	85.33	92.29	99.53	107.03	114.82	122.87	131.20
11 $\frac{1}{4}$	79.52	86.29	93.33	100.65	108.24	116.11	124.25	132.67
11 $\frac{3}{8}$	80.41	87.25	94.37	101.77	109.44	117.40	125.63	134.15
11 $\frac{1}{2}$	81.29	88.20	95.40	102.88	110.64	118.69	127.01	135.62
11 $\frac{5}{8}$	82.17	89.16	96.44	104.00	111.84	119.98	128.39	137.10
11 $\frac{3}{4}$	83.06	90.12	97.48	105.12	113.05	121.27	129.77	138.57
11 $\frac{7}{8}$	83.94	91.08	98.51	106.24	114.25	122.56	131.15	140.05
12	84.83	92.04	99.55	107.35	115.45	123.85	132.54	141.52

Height	DIAMETER							
	4	4 $\frac{1}{8}$	4 $\frac{1}{4}$	4 $\frac{3}{8}$	4 $\frac{1}{2}$	4 $\frac{5}{8}$	4 $\frac{3}{4}$	4 $\frac{7}{8}$
2 $\frac{1}{2}$	31.42	33.41	35.47	37.58	39.76	42.00	44.30	46.66
2 $\frac{5}{8}$	32.99	35.08	37.24	39.46	41.75	44.10	46.52	49.00
2 $\frac{3}{4}$	34.56	36.75	39.01	41.34	43.74	46.20	48.73	51.33
2 $\frac{7}{8}$	36.13	38.42	40.79	43.22	45.72	48.30	50.95	53.66
3	37.70	40.09	42.56	45.10	47.71	50.40	53.16	56.00
3 $\frac{1}{8}$	39.27	41.76	44.33	46.98	49.70	52.50	55.38	58.33
3 $\frac{1}{4}$	40.84	43.43	46.11	48.86	51.69	54.60	57.59	60.66
3 $\frac{3}{8}$	42.41	45.10	47.88	50.74	53.68	56.70	59.81	63.00
3 $\frac{1}{2}$	43.98	46.77	49.65	52.62	55.67	58.80	62.02	65.33
3 $\frac{5}{8}$	45.55	48.44	51.43	54.49	57.65	60.90	64.24	67.66
3 $\frac{3}{4}$	47.12	50.12	53.20	56.37	59.64	63.00	66.45	70.00
3 $\frac{7}{8}$	48.69	51.79	54.97	58.25	61.63	65.10	68.67	72.33
4	50.27	53.46	56.75	60.13	63.62	67.20	70.88	74.66
4 $\frac{1}{8}$	51.84	55.13	58.52	62.01	65.61	69.30	73.10	77.00
4 $\frac{1}{4}$	53.41	56.80	60.29	63.89	67.59	71.40	75.31	79.33
4 $\frac{3}{8}$	54.98	58.47	62.07	65.77	69.58	73.50	77.53	81.66
4 $\frac{1}{2}$	56.55	60.14	63.84	67.65	71.57	75.60	79.74	83.99
4 $\frac{5}{8}$	58.12	61.81	65.61	69.53	73.56	77.70	81.96	86.33
4 $\frac{3}{4}$	59.69	63.48	67.38	71.41	75.55	79.80	84.17	88.66
4 $\frac{7}{8}$	61.26	65.15	69.16	73.29	77.53	81.90	86.39	90.99
5	62.83	66.82	70.93	75.17	79.52	84.00	88.60	93.33
5 $\frac{1}{8}$	64.40	68.49	72.70	77.04	81.51	86.10	90.82	95.66
5 $\frac{1}{4}$	65.97	70.16	74.48	78.92	83.50	88.20	93.03	97.99
5 $\frac{3}{8}$	67.54	71.83	76.25	80.80	85.49	90.30	95.25	100.33
5 $\frac{1}{2}$	69.12	73.50	78.02	82.68	87.47	92.40	97.46	102.66
5 $\frac{5}{8}$	70.69	75.17	79.80	84.56	89.46	94.50	99.68	104.99
5 $\frac{3}{4}$	72.26	76.84	81.57	86.44	91.45	96.60	101.89	107.33
5 $\frac{7}{8}$	73.83	78.51	83.34	88.32	93.44	98.70	104.11	109.66
6	75.40	80.18	85.12	90.20	95.43	100.80	106.32	111.99
6 $\frac{1}{8}$	76.97	81.85	86.89	92.08	97.41	102.90	108.54	114.33
6 $\frac{1}{4}$	78.54	83.53	88.66	93.96	99.40	105.00	110.75	116.66
6 $\frac{3}{8}$	80.11	85.20	90.44	95.83	101.39	107.10	112.97	118.99
6 $\frac{1}{2}$	81.68	86.87	92.21	97.71	103.38	109.20	115.18	121.33
6 $\frac{5}{8}$	83.25	88.54	93.98	99.59	105.37	111.30	117.40	123.66
6 $\frac{3}{4}$	84.82	90.21	95.76	101.47	107.35	113.40	119.61	125.99
6 $\frac{7}{8}$	86.39	91.88	97.53	103.35	109.34	115.50	121.83	128.33
7	87.96	93.55	99.30	105.23	111.33	117.60	124.04	130.66
7 $\frac{1}{8}$	89.54	95.22	101.08	107.11	113.32	119.70	126.26	132.99
7 $\frac{1}{4}$	91.11	96.89	102.85	108.99	115.31	121.80	128.47	135.33

Depth	DIAMETER							
	4	4 $\frac{1}{8}$	4 $\frac{1}{4}$	4 $\frac{3}{8}$	4 $\frac{1}{2}$	4 $\frac{5}{8}$	4 $\frac{3}{4}$	4 $\frac{7}{8}$
7 $\frac{3}{8}$	92.68	98.56	104.63	110.87	117.29	123.90	130.69	137.66
7 $\frac{1}{2}$	94.25	100.23	106.40	112.75	119.28	126.00	132.90	139.99
7 $\frac{5}{8}$	95.82	101.90	108.17	114.63	121.27	128.10	135.12	142.32
7 $\frac{3}{4}$	97.39	103.57	109.94	116.50	123.26	130.20	137.33	144.66
7 $\frac{7}{8}$	98.96	104.24	111.72	118.38	125.25	132.30	139.55	146.99
8	100.53	106.91	113.49	120.26	127.23	134.40	141.76	149.32
8 $\frac{1}{8}$	102.10	108.58	115.26	122.14	129.22	136.50	143.98	151.66
8 $\frac{1}{4}$	103.67	110.25	117.04	124.02	131.21	138.60	146.19	153.99
8 $\frac{3}{8}$	105.24	111.92	118.81	125.90	133.20	140.70	148.41	156.32
8 $\frac{1}{2}$	106.81	113.59	120.58	127.78	135.19	142.80	150.62	158.66
8 $\frac{5}{8}$	108.39	115.26	122.36	129.66	137.18	144.90	152.84	160.99
8 $\frac{3}{4}$	109.96	116.94	124.13	131.54	139.16	147.00	155.05	163.32
8 $\frac{7}{8}$	111.53	118.61	125.90	133.41	141.15	149.10	157.27	165.66
9	113.10	120.28	127.68	135.30	143.14	151.20	159.48	167.99
9 $\frac{1}{8}$	114.67	121.95	129.45	137.18	145.13	153.30	161.70	170.32
9 $\frac{1}{4}$	116.24	123.62	131.22	139.06	147.12	155.40	163.91	172.66
9 $\frac{3}{8}$	117.81	125.29	133.00	140.93	149.10	157.50	166.13	174.99
9 $\frac{1}{2}$	119.38	126.96	134.77	142.81	151.09	159.60	168.34	177.32
9 $\frac{5}{8}$	120.95	128.63	136.54	144.69	153.08	161.70	170.56	179.66
9 $\frac{3}{4}$	122.52	130.30	138.32	146.57	155.07	163.80	172.77	181.99
9 $\frac{7}{8}$	124.09	131.97	140.09	148.45	157.06	165.90	174.99	184.32
10	125.66	133.64	141.86	150.33	159.04	168.00	177.20	186.66
10 $\frac{1}{8}$	127.23	135.31	143.64	152.21	161.03	170.10	179.42	188.99
10 $\frac{1}{4}$	128.81	136.98	145.41	154.09	163.02	172.20	181.63	191.32
10 $\frac{3}{8}$	130.38	138.65	147.18	155.97	165.01	174.30	183.85	193.65
10 $\frac{1}{2}$	131.95	140.32	148.96	157.85	167.00	176.40	186.06	195.99
10 $\frac{5}{8}$	133.52	141.99	150.73	159.73	168.99	178.50	188.28	198.32
10 $\frac{3}{4}$	135.09	143.66	152.50	161.60	170.97	180.60	190.49	200.65
10 $\frac{7}{8}$	136.66	145.33	154.28	163.48	172.96	182.70	192.71	202.99
11	138.23	147.00	156.05	165.36	174.95	184.80	194.92	205.32
11 $\frac{1}{8}$	139.80	148.67	157.82	167.24	176.94	186.90	197.14	207.65
11 $\frac{1}{4}$	141.37	150.35	159.60	169.12	178.93	189.00	199.35	209.99
11 $\frac{3}{8}$	142.94	152.02	161.37	171.00	180.91	191.10	201.57	212.32
11 $\frac{1}{2}$	144.51	153.69	163.14	172.88	182.90	193.20	203.78	214.65
11 $\frac{5}{8}$	146.08	155.36	164.92	174.76	184.88	195.30	206.00	216.99
11 $\frac{3}{4}$	147.66	157.03	166.69	176.64	186.87	197.40	208.21	219.32
11 $\frac{7}{8}$	149.23	158.70	168.46	178.52	188.86	199.50	210.43	221.65
12	150.80	160.37	170.24	180.40	190.85	201.60	212.64	223.99

Depth	DIAMETER							
	5	5 $\frac{1}{8}$	5 $\frac{1}{4}$	5 $\frac{3}{8}$	5 $\frac{1}{2}$	5 $\frac{5}{8}$	5 $\frac{3}{4}$	5 $\frac{7}{8}$
2 $\frac{1}{2}$	49.08	51.57	54.12	56.73	59.40	62.13	64.92	67.77
2 $\frac{5}{8}$	51.54	54.15	56.82	59.56	62.37	65.23	68.16	71.16
2 $\frac{3}{4}$	54.00	56.73	59.53	62.40	65.34	68.34	71.41	74.55
2 $\frac{7}{8}$	56.45	59.31	62.24	65.24	68.31	71.45	74.66	77.94
3	58.91	61.89	64.94	68.07	71.28	74.55	77.90	81.33
3 $\frac{1}{8}$	61.36	64.47	67.65	70.91	74.24	77.66	81.15	84.71
3 $\frac{1}{4}$	63.81	67.04	70.35	73.74	77.21	80.76	84.39	88.10
3 $\frac{3}{8}$	66.27	69.62	73.06	76.58	80.18	83.87	87.64	91.49
3 $\frac{1}{2}$	68.72	72.20	75.76	79.42	83.15	86.98	90.89	94.88
3 $\frac{5}{8}$	71.18	74.78	78.47	82.25	86.12	90.08	94.13	98.27
3 $\frac{3}{4}$	73.63	77.36	81.18	85.09	89.09	93.19	97.38	101.66
3 $\frac{7}{8}$	76.09	79.94	83.88	87.93	92.06	96.20	100.62	105.05
4	78.54	82.52	86.59	90.76	95.03	99.40	103.87	108.43
4 $\frac{1}{8}$	80.99	85.09	89.30	93.60	98.00	102.51	107.12	111.82
4 $\frac{1}{4}$	83.45	87.67	92.00	96.44	100.97	105.61	110.36	115.21
4 $\frac{3}{8}$	85.90	90.25	94.71	99.27	103.94	108.72	113.61	118.60
4 $\frac{1}{2}$	88.36	92.83	97.41	102.61	106.91	111.83	116.85	121.99
4 $\frac{5}{8}$	90.81	95.41	100.12	104.94	109.88	114.93	120.10	125.38
4 $\frac{3}{4}$	93.27	97.99	102.83	107.78	112.85	118.04	123.34	128.77
4 $\frac{7}{8}$	95.72	100.57	105.53	110.62	115.82	121.15	126.59	132.15
5	98.18	103.15	108.24	113.45	118.79	124.25	129.84	135.54
5 $\frac{1}{8}$	100.63	105.72	110.94	116.29	121.76	127.36	133.08	138.93
5 $\frac{1}{4}$	103.08	108.30	113.65	119.13	124.73	130.47	136.33	142.32
5 $\frac{3}{8}$	105.54	110.88	116.36	121.96	127.70	133.57	139.57	145.71
5 $\frac{1}{2}$	107.99	113.46	119.06	124.80	130.67	136.68	142.82	149.10
5 $\frac{5}{8}$	110.45	116.04	121.76	127.64	133.64	139.78	146.07	152.49
5 $\frac{3}{4}$	112.90	118.62	124.47	130.47	136.61	142.89	149.31	155.87
5 $\frac{7}{8}$	115.36	121.20	127.18	133.31	139.58	146.00	152.56	159.26
6	117.81	123.77	129.90	136.14	142.55	149.10	155.80	162.65
6 $\frac{1}{8}$	120.26	126.35	132.59	138.98	145.52	152.21	159.05	166.04
6 $\frac{1}{4}$	122.72	128.93	135.30	141.82	148.49	155.32	162.30	169.43
6 $\frac{3}{8}$	125.17	131.51	138.00	144.66	151.46	158.42	165.54	172.82
6 $\frac{1}{2}$	127.63	134.09	140.71	147.49	154.43	161.53	168.79	176.21
6 $\frac{5}{8}$	130.08	136.67	143.42	150.33	157.40	164.53	172.03	179.59
6 $\frac{3}{4}$	132.54	139.25	146.12	153.16	160.37	167.74	175.28	182.98
6 $\frac{7}{8}$	134.99	141.82	148.83	156.00	163.34	170.85	178.53	186.37
7	137.45	144.40	151.53	158.84	166.31	173.95	181.77	189.76
7 $\frac{1}{8}$	139.90	146.98	154.24	161.67	169.28	177.06	185.02	193.15
7 $\frac{1}{4}$	142.35	149.56	156.95	164.51	172.25	180.16	188.26	196.55

Depth	DIAMETER							
	5	5 $\frac{1}{8}$	5 $\frac{1}{4}$	5 $\frac{3}{8}$	5 $\frac{1}{2}$	5 $\frac{5}{8}$	5 $\frac{3}{4}$	5 $\frac{7}{8}$
7 $\frac{3}{8}$	144.81	152.14	159.65	167.34	175.22	183.27	191.51	199.93
7 $\frac{1}{2}$	147.26	154.72	162.36	170.18	178.19	186.38	194.75	203.31
7 $\frac{5}{8}$	149.72	157.30	165.06	173.02	181.16	189.48	198.00	206.70
7 $\frac{3}{4}$	152.17	159.87	167.77	175.85	184.13	192.59	201.25	210.09
7 $\frac{7}{8}$	154.63	162.45	170.47	178.69	187.10	195.69	204.49	213.48
8	157.08	165.03	173.18	181.53	190.07	198.80	207.74	216.87
8 $\frac{1}{8}$	159.53	167.61	175.89	184.36	193.04	201.91	210.98	220.26
8 $\frac{1}{4}$	161.99	170.19	178.59	187.20	196.01	205.01	214.23	223.65
8 $\frac{3}{8}$	164.44	172.77	181.30	190.03	198.98	208.12	217.48	227.03
8 $\frac{1}{2}$	166.90	175.35	184.00	192.87	201.95	211.22	220.72	230.42
8 $\frac{5}{8}$	169.35	177.93	186.71	195.71	204.92	214.33	223.97	233.81
8 $\frac{3}{4}$	171.81	180.50	189.42	198.54	207.89	217.44	227.21	237.20
8 $\frac{7}{8}$	174.26	183.08	192.12	201.38	210.86	220.54	230.46	240.59
9	176.72	185.66	194.83	204.22	213.83	223.65	233.71	243.98
9 $\frac{1}{8}$	179.17	188.24	197.53	207.05	216.79	226.76	236.95	247.37
9 $\frac{1}{4}$	181.62	190.82	200.24	209.89	219.76	229.87	240.20	250.75
9 $\frac{3}{8}$	184.08	193.40	202.95	212.73	222.73	232.97	243.44	254.14
9 $\frac{1}{2}$	186.53	195.98	205.65	215.56	225.70	236.08	246.69	257.53
9 $\frac{5}{8}$	188.99	198.55	208.36	218.40	228.67	239.19	249.94	260.92
9 $\frac{3}{4}$	191.44	201.13	211.03	221.23	231.64	242.29	253.18	264.31
9 $\frac{7}{8}$	193.90	203.71	213.77	224.07	234.61	245.40	256.43	267.70
10	196.35	206.29	216.48	226.91	237.58	248.50	259.67	271.07
10 $\frac{1}{8}$	198.81	208.87	219.18	229.74	240.55	251.61	262.92	274.47
10 $\frac{1}{4}$	201.26	211.45	221.89	232.58	243.52	254.72	266.16	277.86
10 $\frac{3}{8}$	203.72	214.03	224.59	235.42	246.49	257.82	269.41	281.25
10 $\frac{1}{2}$	206.17	216.61	227.30	238.25	249.46	260.93	272.66	284.64
10 $\frac{5}{8}$	208.62	219.18	230.01	241.09	252.43	264.04	275.90	288.03
10 $\frac{3}{4}$	211.08	221.76	232.71	243.93	255.40	267.14	279.15	291.42
10 $\frac{7}{8}$	213.53	224.34	235.42	246.76	258.37	270.25	282.39	294.81
11	215.99	226.92	238.12	249.60	261.34	273.36	285.64	298.19
11 $\frac{1}{8}$	218.44	229.50	240.83	252.43	264.31	276.46	288.89	301.58
11 $\frac{1}{4}$	220.90	232.08	243.54	255.27	267.28	279.57	292.13	304.97
11 $\frac{3}{8}$	223.35	234.65	246.24	258.11	270.25	282.67	295.38	308.36
11 $\frac{1}{2}$	225.81	237.23	248.95	260.94	273.22	285.78	298.62	311.75
11 $\frac{5}{8}$	228.26	239.81	251.65	263.78	276.19	288.89	301.87	315.14
11 $\frac{3}{4}$	230.72	242.39	254.36	266.62	279.16	291.99	305.12	318.53
11 $\frac{7}{8}$	233.17	244.97	257.76	269.45	282.13	295.10	308.33	321.91
12	235.62	247.55	259.77	272.29	285.10	298.21	311.61	325.30

Depth	DIAMETER							
	6	6 $\frac{1}{8}$	6 $\frac{1}{4}$	6 $\frac{3}{8}$	6 $\frac{1}{2}$	6 $\frac{5}{8}$	6 $\frac{3}{4}$	6 $\frac{7}{8}$
2 $\frac{1}{2}$	70.69	73.66	76.70	79.80	82.96	86.17	89.46	92.81
2 $\frac{5}{8}$	74.22	77.34	80.53	83.79	87.11	90.48	93.94	97.45
2 $\frac{3}{4}$	77.75	81.03	84.37	87.78	91.25	94.79	98.41	102.09
2 $\frac{7}{8}$	81.29	84.71	88.20	91.77	95.40	99.10	102.88	106.73
3	84.82	88.39	92.04	95.76	99.55	103.41	107.35	111.37
3 $\frac{1}{8}$	88.36	92.08	95.87	99.75	103.70	107.11	111.83	116.01
3 $\frac{1}{4}$	91.88	95.76	99.71	103.74	107.85	112.02	116.30	120.65
3 $\frac{3}{8}$	95.42	99.44	103.54	107.73	111.99	116.32	120.77	125.29
3 $\frac{1}{2}$	98.95	103.13	107.38	111.72	116.14	120.64	125.25	129.93
3 $\frac{5}{8}$	102.48	106.81	111.21	115.71	120.29	124.95	129.72	134.57
3 $\frac{3}{4}$	106.02	110.49	115.05	119.70	124.44	129.26	134.19	139.21
3 $\frac{7}{8}$	109.55	114.18	118.88	123.69	128.58	133.56	138.64	143.85
4	113.10	117.86	122.72	127.68	132.73	137.88	143.14	148.49
4 $\frac{1}{8}$	116.63	121.54	126.55	131.67	136.88	142.18	147.61	153.13
4 $\frac{1}{4}$	120.17	125.22	130.39	135.66	141.03	146.49	152.09	157.77
4 $\frac{3}{8}$	123.70	128.91	134.22	139.65	145.18	150.80	156.56	162.41
4 $\frac{1}{2}$	127.24	132.59	138.06	143.64	149.32	155.11	161.03	167.05
4 $\frac{5}{8}$	130.77	136.27	141.89	147.63	153.47	159.42	165.50	171.69
4 $\frac{3}{4}$	134.30	139.96	145.73	151.62	157.62	163.72	169.98	176.33
4 $\frac{7}{8}$	137.84	143.64	149.56	155.61	161.77	168.03	174.45	180.97
5	141.37	147.32	153.40	159.60	165.92	172.34	178.92	185.61
5 $\frac{1}{8}$	144.91	151.01	157.23	163.59	170.06	176.65	183.40	190.25
5 $\frac{1}{4}$	148.44	154.69	161.07	167.58	174.21	180.96	187.87	194.8
5 $\frac{3}{8}$	151.97	158.37	164.90	171.57	178.36	185.27	192.34	199.53
5 $\frac{1}{2}$	155.51	162.06	168.74	175.56	182.51	189.58	196.82	204.27
5 $\frac{5}{8}$	159.04	165.74	172.57	179.55	186.66	193.89	201.29	208.81
5 $\frac{3}{4}$	162.58	169.42	176.40	183.54	190.80	198.19	205.76	213.45
5 $\frac{7}{8}$	166.11	173.10	180.24	187.52	194.95	202.50	210.24	218.09
6	169.65	176.79	184.08	191.51	199.10	206.81	214.71	222.73
6 $\frac{1}{8}$	173.18	180.47	187.91	195.50	203.25	211.12	219.18	227.5
6 $\frac{1}{4}$	176.72	184.15	191.75	199.49	207.39	215.43	223.65	232.01
6 $\frac{3}{8}$	180.25	187.84	195.58	203.48	211.54	219.74	228.13	236.65
6 $\frac{1}{2}$	183.78	191.52	199.42	207.47	215.69	224.05	232.60	241.29
6 $\frac{5}{8}$	187.32	195.20	203.25	211.46	219.84	228.36	237.07	245.93
6 $\frac{3}{4}$	190.85	198.89	207.09	215.45	223.99	232.66	241.55	250.57
6 $\frac{7}{8}$	194.39	202.57	210.92	219.44	228.13	236.97	246.02	255.21
7	197.92	206.25	214.76	223.43	232.28	241.28	250.49	259.85
7 $\frac{1}{8}$	201.46	209.93	218.59	227.42	236.43	245.59	254.97	264.49
7 $\frac{1}{4}$	204.99	213.62	222.43	231.41	240.58	249.90	259.44	269.13

Depth	DIAMETER							
	6	6 $\frac{1}{8}$	6 $\frac{1}{4}$	6 $\frac{3}{8}$	6 $\frac{1}{2}$	6 $\frac{5}{8}$	6 $\frac{3}{4}$	6 $\frac{7}{8}$
7 $\frac{3}{8}$	208.52	217.30	226.26	235.40	244.73	254.21	263.91	273.78
7 $\frac{1}{2}$	212.06	220.98	230.10	239.39	248.87	258.52	268.39	278.42
7 $\frac{5}{8}$	215.59	224.67	233.93	243.38	253.02	262.82	272.86	283.06
7 $\frac{3}{4}$	219.13	228.35	237.77	247.37	257.17	267.13	277.33	287.70
7 $\frac{7}{8}$	222.66	232.03	241.60	251.36	261.32	271.44	281.85	292.34
8	226.20	235.72	245.44	255.35	265.47	275.75	286.28	296.98
8 $\frac{1}{8}$	229.73	239.40	249.27	259.34	269.61	280.06	290.75	301.62
8 $\frac{1}{4}$	233.26	243.08	253.11	263.33	273.76	284.37	295.23	306.26
8 $\frac{3}{8}$	236.80	246.77	256.94	267.32	277.91	288.68	299.70	310.90
8 $\frac{1}{2}$	240.33	250.45	260.78	271.31	282.06	292.98	304.17	315.54
8 $\frac{5}{8}$	243.87	254.13	264.61	275.30	286.20	297.29	308.64	320.18
8 $\frac{3}{4}$	247.40	257.82	268.45	279.29	290.35	301.60	313.12	324.82
8 $\frac{7}{8}$	250.94	261.50	272.28	283.28	294.50	305.91	317.59	329.46
9	254.47	265.18	276.12	287.27	298.65	310.22	322.06	334.10
9 $\frac{1}{8}$	258.00	268.86	279.95	291.26	302.80	314.53	326.54	338.74
9 $\frac{1}{4}$	261.54	272.55	283.79	295.25	306.94	318.84	331.01	343.38
9 $\frac{3}{8}$	265.07	276.23	287.62	299.24	311.09	323.14	335.48	348.02
9 $\frac{1}{2}$	268.61	279.91	291.46	303.23	315.24	327.45	339.96	352.66
9 $\frac{5}{8}$	272.14	283.60	295.29	307.22	319.39	331.76	344.43	357.30
9 $\frac{3}{4}$	275.68	287.28	299.13	311.21	323.54	336.07	348.90	361.94
9 $\frac{7}{8}$	279.21	290.96	302.96	315.20	327.68	340.38	353.37	366.58
10	282.74	294.65	306.80	319.19	331.83	344.69	357.85	371.22
10 $\frac{1}{8}$	286.28	298.33	310.63	323.18	335.98	349.00	362.32	375.86
10 $\frac{1}{4}$	289.81	302.01	314.47	327.17	340.13	353.30	366.79	380.50
10 $\frac{3}{8}$	293.35	305.69	318.30	331.16	344.28	357.61	371.27	385.14
10 $\frac{1}{2}$	296.88	309.38	322.13	335.15	348.42	361.92	375.74	389.78
10 $\frac{5}{8}$	300.42	313.06	325.97	339.14	352.57	366.23	380.21	394.42
10 $\frac{3}{4}$	303.95	316.74	329.81	343.13	356.72	370.54	384.69	399.06
10 $\frac{7}{8}$	307.48	320.43	333.64	347.12	360.87	374.85	389.16	403.70
11	311.02	324.10	337.48	351.11	365.01	379.16	393.63	408.34
11 $\frac{1}{8}$	314.55	327.78	341.31	355.10	369.16	383.46	398.11	412.98
11 $\frac{1}{4}$	318.09	331.47	345.15	359.09	373.31	387.77	402.58	417.62
11 $\frac{3}{8}$	321.62	335.15	348.98	363.08	377.46	392.08	407.05	422.26
11 $\frac{1}{2}$	325.16	338.83	352.82	367.07	381.61	396.39	411.52	426.90
11 $\frac{5}{8}$	328.69	342.52	356.65	371.06	385.75	400.70	416.00	431.54
11 $\frac{3}{4}$	332.22	346.20	360.49	375.05	389.90	405.01	420.47	436.18
11 $\frac{7}{8}$	335.75	349.88	364.32	379.04	394.05	409.32	424.94	440.82
12	339.29	353.57	368.16	383.03	398.20	413.63	429.42	445.46

Depth	DIAMETER							
	7	7 $\frac{1}{8}$	7 $\frac{1}{4}$	7 $\frac{3}{8}$	7 $\frac{1}{2}$	7 $\frac{5}{8}$	7 $\frac{3}{4}$	7 $\frac{7}{8}$
2 $\frac{1}{8}$	96.21	99.68	103.21	106.80	110.45	114.16	117.93	121.77
2 $\frac{5}{8}$	101.02	104.66	108.37	112.14	115.97	119.87	123.83	127.86
2 $\frac{3}{4}$	105.83	109.65	113.53	117.48	121.49	125.57	129.73	133.94
2 $\frac{7}{8}$	110.64	114.63	118.69	122.82	127.01	131.28	135.62	140.03
3	115.45	119.61	123.85	128.16	132.54	136.99	141.52	146.12
3 $\frac{1}{8}$	120.26	124.60	129.01	133.50	138.06	142.70	147.42	152.21
3 $\frac{1}{4}$	125.03	129.58	134.17	138.83	143.58	148.41	153.31	158.30
3 $\frac{3}{8}$	129.89	134.57	139.33	144.17	149.10	154.11	159.21	164.39
3 $\frac{1}{2}$	134.70	139.55	144.49	149.51	154.62	159.82	165.11	170.47
3 $\frac{5}{8}$	139.51	144.53	149.65	154.85	160.15	165.53	171.00	176.56
3 $\frac{3}{4}$	144.32	149.52	154.81	160.19	165.67	171.25	176.90	182.65
3 $\frac{7}{8}$	149.13	154.50	159.97	165.53	171.19	176.95	182.80	188.74
4	153.94	159.49	165.13	170.87	176.72	182.65	188.69	194.83
4 $\frac{1}{8}$	158.75	164.47	170.29	176.21	182.24	188.36	194.59	200.92
4 $\frac{1}{4}$	163.56	169.45	175.45	181.55	187.76	194.07	200.49	207.01
4 $\frac{3}{8}$	168.37	174.44	180.61	186.89	193.28	199.78	206.38	213.09
4 $\frac{1}{2}$	173.18	179.42	185.77	192.23	198.80	205.49	212.28	219.18
4 $\frac{5}{8}$	177.99	184.40	190.93	197.57	204.33	211.19	218.18	225.27
4 $\frac{3}{4}$	182.80	189.39	196.09	202.91	209.85	216.90	224.07	231.36
4 $\frac{7}{8}$	187.61	194.37	201.25	208.25	215.37	222.61	229.97	237.45
5	192.42	199.36	206.41	213.59	220.89	228.32	235.87	243.54
5 $\frac{1}{8}$	197.23	204.34	211.57	218.93	226.42	234.03	241.76	249.62
5 $\frac{1}{4}$	202.04	209.32	216.73	224.27	231.94	239.73	247.66	255.71
5 $\frac{3}{8}$	203.85	214.31	221.89	229.61	237.46	245.44	253.56	261.80
5 $\frac{1}{2}$	211.67	219.29	227.05	234.95	242.98	251.15	259.45	267.89
5 $\frac{5}{8}$	216.48	224.28	232.21	240.29	248.51	256.86	265.35	273.98
5 $\frac{3}{4}$	221.29	229.26	237.37	245.63	254.03	262.57	271.25	280.07
5 $\frac{7}{8}$	226.10	234.24	242.54	250.97	259.55	268.27	277.14	286.15
6	230.91	239.23	247.70	256.31	265.07	273.98	283.04	292.24
6 $\frac{1}{8}$	235.72	244.21	252.86	261.65	270.59	279.69	288.94	298.33
6 $\frac{1}{4}$	240.53	249.20	258.02	266.99	276.12	285.40	294.83	304.42
6 $\frac{3}{8}$	245.34	254.18	263.18	272.33	281.64	291.11	300.73	310.51
6 $\frac{1}{2}$	250.15	259.16	268.34	277.67	287.16	296.81	306.63	316.60
6 $\frac{5}{8}$	254.96	264.15	273.50	283.01	292.68	302.52	312.52	322.68
6 $\frac{3}{4}$	259.77	269.13	278.66	288.35	298.21	308.23	318.42	328.77
6 $\frac{7}{8}$	264.58	274.12	283.82	293.69	303.73	313.94	324.31	334.86
7	269.33	279.10	288.98	299.03	309.25	319.65	330.21	340.95
7 $\frac{1}{8}$	274.20	284.08	294.14	304.37	314.77	325.35	336.11	347.04
7 $\frac{1}{4}$	279.01	289.07	299.30	309.71	320.30	331.06	342.01	353.13

Depth	DIAMETER							
	7	7 $\frac{1}{8}$	7 $\frac{1}{4}$	7 $\frac{3}{8}$	7 $\frac{1}{2}$	7 $\frac{5}{8}$	7 $\frac{3}{4}$	7 $\frac{7}{8}$
7 $\frac{3}{8}$	283.82	294.05	304.46	315.05	325.82	336.77	347.90	359.21
7 $\frac{1}{2}$	288.63	299.03	309.62	320.39	331.34	342.48	353.80	365.30
7 $\frac{5}{8}$	293.45	304.02	314.78	325.73	336.86	348.18	359.69	371.39
7 $\frac{3}{4}$	298.26	309.00	319.94	331.07	342.39	353.89	365.59	377.48
7 $\frac{7}{8}$	303.07	313.99	325.10	336.41	347.91	359.60	371.49	383.57
8	307.88	318.97	330.26	341.75	353.43	365.31	377.38	389.66
8 $\frac{1}{8}$	312.69	323.95	335.42	347.09	358.95	371.02	383.28	395.75
8 $\frac{1}{4}$	317.50	328.94	340.58	352.43	364.47	376.72	389.18	401.83
8 $\frac{3}{8}$	322.31	333.92	345.74	357.77	370.00	382.43	395.07	407.92
8 $\frac{1}{2}$	327.12	338.91	350.90	363.11	375.52	388.14	400.97	414.01
8 $\frac{5}{8}$	331.93	343.89	356.06	368.45	381.04	393.85	406.87	420.10
8 $\frac{3}{4}$	336.74	348.87	361.22	373.79	386.56	399.56	412.76	426.19
8 $\frac{7}{8}$	341.55	353.86	366.38	379.13	392.09	405.26	418.66	432.28
9	346.36	358.84	371.54	384.47	397.61	410.97	424.56	438.36
9 $\frac{1}{8}$	351.17	363.83	376.70	389.81	403.13	416.68	430.45	444.45
9 $\frac{1}{4}$	355.98	368.81	381.86	395.15	408.65	422.39	436.35	450.54
9 $\frac{3}{8}$	360.79	373.79	387.02	400.49	414.18	428.10	442.25	456.63
9 $\frac{1}{2}$	365.60	378.78	392.18	405.82	419.70	433.80	448.14	462.72
9 $\frac{5}{8}$	370.41	383.76	397.34	411.16	425.22	439.51	454.04	468.81
9 $\frac{3}{4}$	375.23	388.75	402.51	416.50	430.74	445.22	459.94	474.89
9 $\frac{7}{8}$	380.04	393.73	407.67	421.84	436.27	450.93	465.83	480.98
10	384.85	398.71	412.83	427.18	441.79	456.64	471.73	487.07
10 $\frac{1}{8}$	389.66	403.70	417.99	432.52	447.31	462.34	477.63	493.16
10 $\frac{1}{4}$	394.47	408.68	423.15	437.86	452.83	468.05	483.52	499.25
10 $\frac{3}{8}$	399.28	413.66	428.31	443.20	458.35	473.76	489.42	505.34
10 $\frac{1}{2}$	404.09	418.65	433.47	448.54	463.88	479.47	495.32	511.42
10 $\frac{5}{8}$	408.90	423.63	438.63	453.88	469.40	485.18	501.21	517.51
10 $\frac{3}{4}$	413.71	428.62	443.79	459.22	474.92	490.88	507.11	523.60
10 $\frac{7}{8}$	418.52	433.60	448.95	464.56	480.44	496.59	513.01	529.69
11	423.33	438.58	454.11	469.90	485.97	502.30	518.90	535.78
11 $\frac{1}{8}$	428.14	443.57	459.27	475.24	491.49	508.01	524.80	541.87
11 $\frac{1}{4}$	432.95	448.55	464.43	480.58	497.01	513.72	530.70	547.95
11 $\frac{3}{8}$	437.76	453.54	469.59	485.92	502.53	519.42	536.59	554.04
11 $\frac{1}{2}$	442.57	458.52	474.75	491.26	508.06	525.13	542.49	560.13
11 $\frac{5}{8}$	447.38	463.50	479.91	496.60	513.58	530.84	548.39	566.22
11 $\frac{3}{4}$	452.19	468.49	485.07	501.94	519.10	536.55	554.28	572.31
11 $\frac{7}{8}$	457.00	473.47	490.23	507.28	524.62	542.25	560.18	578.40
12	461.82	478.46	495.39	512.62	530.15	547.96	566.08	584.48

Depth	DIAMETER							
	8	8 $\frac{1}{8}$	8 $\frac{1}{4}$	8 $\frac{3}{8}$	8 $\frac{1}{2}$	8 $\frac{5}{8}$	8 $\frac{3}{4}$	8 $\frac{7}{8}$
2 $\frac{1}{8}$	125.66	129.62	133.64	137.72	141.86	146.07	150.33	154.63
2 $\frac{3}{8}$	131.95	136.10	140.32	144.61	148.96	153.37	157.85	162.39
2 $\frac{1}{2}$	138.23	142.58	147.00	151.49	156.05	160.67	165.36	170.12
2 $\frac{7}{8}$	144.51	149.06	153.69	158.38	163.14	167.98	172.88	177.85
3	150.80	155.55	160.37	165.27	170.24	175.28	180.40	185.59
3 $\frac{1}{8}$	157.08	162.03	167.05	172.15	177.33	182.58	187.91	193.32
3 $\frac{1}{4}$	163.36	168.51	173.73	179.04	184.42	189.89	195.43	201.05
3 $\frac{3}{8}$	169.65	174.99	180.41	185.92	191.51	197.19	202.95	208.79
3 $\frac{1}{2}$	175.93	181.47	187.10	192.81	198.61	204.49	210.46	216.52
3 $\frac{5}{8}$	182.21	187.95	193.78	199.70	205.70	211.80	217.99	224.25
3 $\frac{3}{4}$	188.50	194.43	200.46	206.58	212.79	219.10	225.50	231.98
3 $\frac{7}{8}$	194.78	200.91	207.14	213.47	219.89	226.40	233.01	239.72
4	201.06	207.39	213.83	220.35	226.98	233.71	240.53	247.45
4 $\frac{1}{8}$	207.35	213.88	220.51	227.24	234.07	241.01	248.05	255.18
4 $\frac{1}{4}$	213.63	220.36	227.19	234.13	241.17	248.31	255.56	262.92
4 $\frac{3}{8}$	219.91	226.84	233.87	241.01	248.26	255.62	263.08	270.65
4 $\frac{1}{2}$	226.20	233.32	240.55	247.90	255.35	262.92	270.59	278.38
4 $\frac{5}{8}$	232.48	249.80	247.24	254.78	262.45	270.22	278.11	286.11
4 $\frac{3}{4}$	238.76	246.28	253.92	261.67	269.54	277.53	285.63	293.85
4 $\frac{7}{8}$	245.04	252.76	260.60	268.56	276.63	284.83	293.14	301.58
5	251.33	259.24	267.28	275.44	283.73	292.13	300.66	309.31
5 $\frac{1}{8}$	257.61	265.72	273.96	282.33	290.82	299.44	308.18	317.05
5 $\frac{1}{4}$	263.89	272.21	280.65	289.21	297.91	306.74	315.69	324.78
5 $\frac{3}{8}$	270.18	278.69	287.33	296.10	305.01	314.04	323.21	332.51
5 $\frac{1}{2}$	276.46	285.17	294.01	303.99	312.10	321.35	330.73	340.24
5 $\frac{5}{8}$	282.74	291.65	300.69	309.87	319.19	328.65	338.24	347.98
5 $\frac{3}{4}$	289.03	298.13	307.37	316.76	326.28	335.95	345.76	355.71
5 $\frac{7}{8}$	295.31	304.61	314.06	323.64	333.38	343.26	353.28	363.44
6	301.59	311.09	320.74	330.53	340.47	350.56	360.79	371.18
6 $\frac{1}{8}$	307.88	317.57	327.42	337.42	347.56	357.86	368.31	378.91
6 $\frac{1}{4}$	314.16	324.05	334.10	344.30	354.66	365.17	375.83	386.64
6 $\frac{3}{8}$	320.44	330.54	340.78	351.19	361.75	372.47	383.34	394.37
6 $\frac{1}{2}$	326.73	337.02	347.47	358.07	368.84	379.77	390.86	402.11
6 $\frac{5}{8}$	333.01	343.50	354.15	364.96	375.94	387.07	398.38	409.84
6 $\frac{3}{4}$	339.29	349.98	360.83	371.85	383.03	394.38	405.89	417.57
6 $\frac{7}{8}$	345.58	356.46	366.51	378.73	390.12	401.68	413.41	425.30
7	351.86	362.94	374.19	385.62	397.22	408.98	420.93	433.04
7 $\frac{1}{8}$	358.14	369.42	380.98	392.51	404.31	416.29	428.44	440.77
7 $\frac{1}{4}$	364.43	375.90	387.56	399.39	411.40	423.59	435.96	448.50

Depth	DIAMETER							
	8	8 $\frac{1}{8}$	8 $\frac{1}{4}$	8 $\frac{3}{8}$	8 $\frac{1}{2}$	8 $\frac{5}{8}$	8 $\frac{3}{4}$	8 $\frac{7}{8}$
7 $\frac{3}{8}$	370.71	382.38	394.24	406.28	418.50	430.89	443.47	456.24
7 $\frac{1}{2}$	376.99	388.87	400.92	413.16	425.59	438.20	450.99	463.97
7 $\frac{5}{8}$	383.28	395.35	407.60	420.05	432.68	445.50	458.51	471.70
7 $\frac{3}{4}$	389.56	401.83	414.29	426.94	439.77	452.80	466.02	479.43
7 $\frac{7}{8}$	395.84	408.31	420.97	433.82	446.87	460.11	473.54	487.17
8	402.12	414.79	427.65	440.71	453.96	467.41	481.06	494.90
8 $\frac{1}{8}$	408.41	421.27	434.33	447.59	461.05	474.71	488.57	502.63
8 $\frac{1}{4}$	414.69	427.75	441.01	454.48	468.15	482.02	496.09	510.37
8 $\frac{3}{8}$	420.97	434.23	447.70	461.37	475.24	489.32	503.61	518.10
8 $\frac{1}{2}$	427.26	440.71	454.38	468.25	482.33	496.62	511.12	525.83
8 $\frac{5}{8}$	433.54	447.19	461.06	475.14	489.43	503.93	518.64	533.56
8 $\frac{3}{4}$	439.82	453.68	467.74	482.02	496.52	511.23	526.16	541.30
8 $\frac{7}{8}$	446.11	460.16	474.42	488.91	503.61	518.53	533.67	549.03
9	452.39	466.64	481.11	495.80	510.71	525.84	541.19	556.76
9 $\frac{1}{8}$	458.67	473.12	487.79	502.68	517.80	533.14	548.71	564.50
9 $\frac{1}{4}$	464.96	479.60	494.47	509.57	524.89	540.44	556.22	572.23
9 $\frac{3}{8}$	471.24	486.08	501.15	516.45	531.99	547.75	563.74	579.96
9 $\frac{1}{2}$	477.52	492.56	507.83	523.34	539.08	555.05	571.26	587.69
9 $\frac{5}{8}$	483.81	499.04	514.52	530.23	546.17	562.35	578.77	595.43
9 $\frac{3}{4}$	490.09	505.52	521.20	537.11	553.27	569.66	586.29	603.16
9 $\frac{7}{8}$	496.37	512.01	527.88	544.00	560.36	576.96	593.81	610.89
10	502.66	518.49	534.56	550.88	567.45	584.26	601.32	618.63
10 $\frac{1}{8}$	508.94	524.97	541.24	557.77	574.54	591.57	608.84	626.36
10 $\frac{1}{4}$	515.22	531.45	547.93	564.66	581.64	598.87	616.35	634.09
10 $\frac{3}{8}$	521.51	537.93	554.61	571.54	588.73	606.17	623.87	641.82
10 $\frac{1}{2}$	527.79	544.41	561.29	578.43	595.82	613.48	631.39	649.56
10 $\frac{5}{8}$	534.07	550.89	567.97	585.31	602.92	620.78	638.90	657.29
10 $\frac{3}{4}$	540.36	557.37	574.65	592.20	610.01	628.08	646.42	665.02
10 $\frac{7}{8}$	546.64	563.85	581.34	599.09	617.10	635.39	653.94	672.75
11	552.92	570.34	588.02	605.97	624.20	642.69	661.45	680.49
11 $\frac{1}{8}$	559.20	576.82	594.70	612.86	631.29	649.99	668.97	688.22
11 $\frac{1}{4}$	565.49	583.30	601.38	619.75	638.38	657.30	676.49	695.95
11 $\frac{3}{8}$	571.77	589.78	608.07	626.63	645.48	664.60	684.00	703.69
11 $\frac{1}{2}$	578.05	596.26	614.75	633.52	652.57	671.90	691.52	711.42
11 $\frac{5}{8}$	584.34	602.74	621.43	640.40	659.66	679.21	699.04	719.15
11 $\frac{3}{4}$	590.62	609.22	628.11	647.29	666.76	686.51	707.55	726.88
11 $\frac{7}{8}$	596.90	615.70	634.79	654.18	673.85	693.81	714.07	734.62
12	603.19	622.18	641.48	661.06	680.94	701.12	721.59	742.35

Depth	DIAMETER							
	9	9 $\frac{1}{8}$	9 $\frac{1}{4}$	9 $\frac{3}{8}$	9 $\frac{1}{2}$	9 $\frac{5}{8}$	9 $\frac{3}{4}$	9 $\frac{7}{8}$
2 $\frac{1}{16}$	159.04	163.49	168.00	172.57	177.21	181.90	186.66	191.47
2 $\frac{1}{8}$	167.00	171.67	176.40	181.20	186.07	190.99	195.99	201.05
2 $\frac{3}{8}$	174.95	179.84	184.80	189.83	194.93	200.09	205.32	210.62
2 $\frac{1}{2}$	182.90	188.02	193.20	198.46	203.79	209.18	214.65	220.19
3	190.85	196.19	201.60	207.09	212.65	218.28	223.99	229.77
3 $\frac{1}{8}$	198.80	204.37	210.00	215.72	221.51	227.37	233.32	239.34
3 $\frac{1}{4}$	206.76	212.54	218.40	224.35	230.37	236.47	242.65	248.91
3 $\frac{3}{8}$	214.71	220.71	226.80	232.97	239.23	245.56	251.98	258.49
3 $\frac{1}{2}$	222.66	228.89	235.20	241.60	248.09	254.66	261.32	268.06
3 $\frac{5}{8}$	230.61	237.06	243.60	250.23	256.95	263.75	270.65	277.63
3 $\frac{3}{4}$	238.57	245.24	252.00	258.86	265.81	272.85	279.98	287.21
3 $\frac{7}{8}$	246.52	253.41	260.40	267.49	274.67	281.94	289.32	296.78
4	254.47	261.59	268.80	276.12	283.53	291.04	298.65	306.36
4 $\frac{1}{8}$	262.42	269.76	277.20	284.75	292.39	300.13	307.98	315.93
4 $\frac{1}{4}$	270.37	277.94	285.60	293.37	301.25	309.23	317.31	325.50
4 $\frac{3}{8}$	278.33	286.11	294.00	302.00	310.11	318.32	326.65	335.08
4 $\frac{1}{2}$	286.28	294.29	302.40	310.63	318.97	327.42	335.98	344.65
4 $\frac{5}{8}$	294.23	302.46	310.80	319.26	327.83	336.51	345.31	354.22
4 $\frac{3}{4}$	302.18	310.63	319.20	327.89	336.69	345.61	354.64	363.80
4 $\frac{7}{8}$	310.15	318.81	327.60	336.52	345.55	354.70	363.98	373.37
5	318.09	326.98	336.00	345.15	354.41	363.80	373.31	382.94
5 $\frac{1}{8}$	326.04	335.16	344.40	353.78	363.27	372.89	382.64	392.52
5 $\frac{1}{4}$	333.99	343.33	352.80	362.40	372.13	381.99	391.98	402.09
5 $\frac{3}{8}$	341.95	351.51	361.20	371.03	380.99	391.08	401.31	411.66
5 $\frac{1}{2}$	349.90	359.68	369.60	379.66	389.85	400.18	410.64	421.24
5 $\frac{5}{8}$	357.85	367.86	378.00	388.29	398.71	409.27	419.97	430.81
5 $\frac{3}{4}$	365.80	376.03	386.40	396.92	407.57	418.37	429.31	440.39
5 $\frac{7}{8}$	373.75	384.21	394.80	405.55	416.43	427.46	438.64	449.96
6	381.71	392.38	403.20	414.18	425.29	436.56	447.97	459.53
6 $\frac{1}{8}$	389.66	400.56	411.60	422.80	434.15	445.65	457.31	469.11
6 $\frac{1}{4}$	397.61	408.73	420.01	431.43	443.01	454.75	466.64	478.68
6 $\frac{3}{8}$	405.56	416.90	428.41	440.06	451.87	463.84	475.97	488.25
6 $\frac{1}{2}$	413.51	425.08	436.81	448.69	460.74	472.94	485.30	497.83
6 $\frac{5}{8}$	421.47	433.25	445.21	457.32	469.60	482.03	494.64	507.40
6 $\frac{3}{4}$	429.41	441.43	453.61	465.95	478.46	491.13	503.97	516.97
6 $\frac{7}{8}$	437.37	449.60	462.01	474.58	487.32	500.23	513.30	526.55
7	445.32	457.78	470.41	483.21	496.18	509.32	522.63	536.12
7 $\frac{1}{8}$	453.27	465.95	478.81	491.83	505.04	518.41	531.97	545.70
7 $\frac{1}{4}$	461.23	474.13	487.21	500.46	513.90	527.51	541.30	555.27

Depth.	DIAMETER							
	9	9 $\frac{1}{8}$	9 $\frac{1}{4}$	9 $\frac{3}{8}$	9 $\frac{1}{2}$	9 $\frac{5}{8}$	9 $\frac{3}{4}$	9 $\frac{7}{8}$
7 $\frac{3}{8}$	469.18	482.30	495.61	509.09	522.76	536.60	550.63	564.84
7 $\frac{1}{2}$	477.13	490.48	504.01	517.72	531.62	545.70	559.97	574.42
7 $\frac{5}{8}$	485.08	498.65	512.41	526.35	540.48	554.79	569.30	583.99
7 $\frac{3}{4}$	493.04	506.83	520.81	534.98	549.34	563.89	578.63	593.56
7 $\frac{7}{8}$	500.99	515.00	529.21	543.61	558.20	572.98	587.96	603.14
8	508.94	523.17	537.61	552.23	567.06	582.08	597.30	612.71
8 $\frac{1}{8}$	516.89	531.35	546.01	560.86	575.92	591.17	606.63	622.28
8 $\frac{1}{4}$	524.84	539.52	554.41	569.49	584.78	600.27	615.96	631.86
8 $\frac{3}{8}$	532.80	547.70	562.81	578.12	593.64	609.36	625.30	641.43
8 $\frac{1}{2}$	540.75	555.87	571.21	586.75	602.50	618.46	634.63	651.00
8 $\frac{5}{8}$	548.70	564.05	579.61	595.38	611.36	627.55	643.96	660.58
8 $\frac{3}{4}$	556.65	572.22	588.01	604.01	620.22	636.65	653.29	670.15
8 $\frac{7}{8}$	564.61	580.40	596.41	612.64	628.08	645.74	662.63	679.73
9	572.56	588.57	604.81	621.26	637.94	654.84	671.96	689.30
9 $\frac{1}{8}$	580.51	596.75	613.21	629.89	646.80	663.93	681.29	698.87
9 $\frac{1}{4}$	588.46	604.92	621.61	638.52	655.66	673.03	690.62	708.45
9 $\frac{3}{8}$	596.41	613.10	630.01	647.15	664.52	682.12	699.96	718.02
9 $\frac{1}{2}$	604.37	621.27	638.41	655.78	673.38	691.22	709.29	727.59
9 $\frac{5}{8}$	612.32	629.44	646.81	664.41	682.24	700.31	718.62	737.17
9 $\frac{3}{4}$	620.27	637.62	655.21	673.04	691.10	709.41	727.96	746.74
9 $\frac{7}{8}$	628.22	645.79	663.61	681.66	699.96	718.50	737.29	756.31
10	336.18	653.97	672.01	690.29	708.82	727.60	746.62	765.89
10 $\frac{1}{8}$	344.13	662.14	680.41	698.92	717.68	736.69	755.95	775.46
10 $\frac{1}{4}$	652.08	670.32	688.81	707.52	726.54	745.79	765.29	785.04
10 $\frac{3}{8}$	660.03	678.49	697.21	716.18	735.40	754.88	774.62	794.61
10 $\frac{1}{2}$	667.98	686.67	705.61	724.81	744.26	763.98	783.95	804.18
10 $\frac{5}{8}$	675.94	694.84	714.01	733.44	753.12	773.07	793.28	813.76
10 $\frac{3}{4}$	683.89	703.02	722.41	742.06	761.99	782.17	802.62	823.33
10 $\frac{7}{8}$	691.84	711.19	730.81	750.69	770.85	791.26	811.95	832.90
11	699.79	719.37	739.21	759.32	779.71	800.36	821.28	842.48
11 $\frac{1}{8}$	707.74	727.54	747.61	767.95	788.57	810.45	830.62	852.05
11 $\frac{1}{4}$	715.70	735.71	756.01	776.58	797.43	819.55	839.95	861.62
11 $\frac{3}{8}$	723.65	743.89	764.41	785.21	806.29	828.64	849.28	871.20
11 $\frac{1}{2}$	731.60	752.06	772.81	793.84	815.15	837.74	858.61	880.77
11 $\frac{5}{8}$	739.55	760.24	781.21	802.47	824.01	846.83	867.95	890.34
11 $\frac{3}{4}$	747.50	768.41	789.61	811.19	832.87	855.93	877.29	899.92
11 $\frac{7}{8}$	755.46	776.59	798.01	819.72	841.73	864.02	886.61	909.49
12	763.41	784.76	806.41	828.35	850.59	873.12	895.95	919.07

Depth	DIAMETER							
	10	10 $\frac{1}{8}$	10 $\frac{1}{4}$	10 $\frac{3}{8}$	10 $\frac{1}{2}$	10 $\frac{5}{8}$	10 $\frac{3}{4}$	10 $\frac{7}{8}$
2 $\frac{1}{2}$	196.35	201.29	206.29	211.35	216.48	221.66	226.91	232.21
2 $\frac{5}{8}$	206.17	211.35	216.60	221.92	227.30	232.74	238.25	243.83
2 $\frac{3}{4}$	215.99	221.42	226.92	232.49	238.12	243.83	249.60	255.44
2 $\frac{7}{8}$	225.80	231.48	237.23	243.06	248.95	254.91	260.94	267.05
3	235.62	241.55	247.55	253.62	259.77	265.99	272.29	278.66
3 $\frac{1}{8}$	245.44	251.61	257.86	264.19	270.59	277.08	283.63	290.27
3 $\frac{1}{4}$	255.26	261.68	268.18	274.76	281.42	288.16	294.98	301.88
3 $\frac{3}{8}$	265.07	271.74	278.49	285.33	292.24	299.24	306.32	313.49
3 $\frac{1}{2}$	274.89	281.81	288.81	295.89	303.07	310.33	317.67	325.10
3 $\frac{5}{8}$	284.71	291.87	299.12	306.46	313.89	321.41	329.02	336.71
3 $\frac{3}{4}$	294.53	301.93	309.44	317.03	324.71	332.49	340.36	348.32
3 $\frac{7}{8}$	304.34	312.00	319.75	327.60	335.54	343.57	351.71	359.93
4	314.16	322.06	330.06	338.16	346.36	354.66	363.05	371.54
4 $\frac{1}{8}$	323.98	332.13	340.38	348.73	357.19	365.74	374.40	383.15
4 $\frac{1}{4}$	333.80	342.19	350.69	359.30	368.01	376.82	385.74	394.76
4 $\frac{3}{8}$	343.61	352.26	361.01	369.87	378.83	387.91	397.09	406.38
4 $\frac{1}{2}$	353.43	362.32	371.32	380.43	389.66	399.99	408.43	417.99
4 $\frac{5}{8}$	363.25	372.39	381.64	391.00	400.48	410.07	419.78	429.60
4 $\frac{3}{4}$	373.07	382.45	391.95	401.57	411.30	421.16	431.12	441.21
4 $\frac{7}{8}$	382.88	392.51	402.27	412.14	422.13	432.24	442.47	452.82
5	392.70	402.58	412.58	422.70	432.95	443.32	453.81	464.43
5 $\frac{1}{8}$	402.52	412.64	422.90	433.27	443.78	454.40	465.16	476.04
5 $\frac{1}{4}$	412.34	422.71	433.21	443.84	454.60	465.49	476.50	487.65
5 $\frac{3}{8}$	422.15	432.77	443.52	454.41	465.42	476.57	487.85	499.26
5 $\frac{1}{2}$	431.97	442.84	453.84	464.98	476.25	487.65	499.20	510.87
5 $\frac{5}{8}$	441.79	452.90	464.15	475.54	487.07	498.74	510.54	522.48
5 $\frac{3}{4}$	451.61	462.97	474.47	486.11	497.89	509.82	521.89	534.09
5 $\frac{7}{8}$	461.42	473.03	484.78	496.68	508.72	520.90	533.23	545.70
6	471.24	483.09	495.10	507.25	519.54	531.99	544.58	557.31
6 $\frac{1}{8}$	481.06	493.16	505.41	517.81	530.37	543.07	555.92	568.93
6 $\frac{1}{4}$	490.88	503.22	515.73	528.38	541.19	554.15	567.27	580.54
6 $\frac{3}{8}$	500.69	513.29	526.04	538.95	552.01	565.23	578.61	592.15
6 $\frac{1}{2}$	510.51	523.35	536.35	549.52	562.85	576.32	589.96	603.76
6 $\frac{5}{8}$	520.33	533.42	546.67	560.08	573.66	587.40	601.30	615.37
6 $\frac{3}{4}$	530.15	543.48	556.98	570.65	584.48	598.48	612.65	626.98
6 $\frac{7}{8}$	539.96	553.55	567.30	581.22	595.31	609.57	623.99	638.59
7	549.78	563.61	577.61	591.79	606.13	620.65	635.34	650.20
7 $\frac{1}{8}$	559.60	573.67	587.93	602.35	616.96	631.73	646.68	661.81
7 $\frac{1}{4}$	569.42	583.74	598.24	612.92	627.78	642.82	658.03	673.42

Depth	DIAMETER							
	10	10 $\frac{1}{8}$	10 $\frac{1}{4}$	10 $\frac{3}{8}$	10 $\frac{1}{2}$	10 $\frac{5}{8}$	10 $\frac{3}{4}$	10 $\frac{7}{8}$
7 $\frac{3}{8}$	579.23	593.80	608.56	623.49	638.60	653.90	669.38	685.03
7 $\frac{1}{2}$	589.05	603.87	618.87	634.06	649.43	664.98	680.72	696.64
7 $\frac{5}{8}$	598.87	613.93	629.19	644.62	660.25	676.07	692.07	708.25
7 $\frac{3}{4}$	608.69	624.00	639.50	655.19	671.08	687.15	703.41	719.87
7 $\frac{7}{8}$	618.50	634.06	649.81	665.76	681.90	698.23	714.76	731.48
8	628.32	644.13	660.13	676.33	692.72	709.31	726.10	743.09
8 $\frac{1}{8}$	638.14	654.19	670.44	686.90	703.55	720.40	737.45	754.70
8 $\frac{1}{4}$	647.96	664.26	680.76	697.46	714.37	731.48	748.79	766.31
8 $\frac{3}{8}$	657.77	674.32	691.07	708.03	725.19	742.56	760.14	777.92
8 $\frac{1}{2}$	667.59	684.38	701.39	718.60	736.02	753.65	771.48	789.53
8 $\frac{5}{8}$	677.41	694.45	711.70	729.17	746.84	764.73	782.82	801.14
8 $\frac{3}{4}$	687.23	704.51	722.02	739.73	757.67	775.81	794.17	812.75
8 $\frac{7}{8}$	697.04	714.58	732.33	750.30	768.49	786.90	805.52	824.36
9	706.86	724.63	742.64	760.87	779.31	797.98	816.87	835.97
9 $\frac{1}{8}$	716.68	734.71	752.96	771.44	790.14	809.06	828.21	847.58
9 $\frac{1}{4}$	726.50	744.77	763.27	782.00	800.96	820.14	839.56	859.19
9 $\frac{3}{8}$	736.31	754.84	773.59	792.57	811.78	831.23	850.90	870.80
9 $\frac{1}{2}$	746.13	764.90	783.90	803.14	822.61	842.31	862.25	882.42
9 $\frac{5}{8}$	755.95	774.96	794.22	813.71	833.43	853.39	873.59	894.03
9 $\frac{3}{4}$	765.77	785.03	804.53	824.27	844.26	864.48	884.94	905.64
9 $\frac{7}{8}$	775.58	795.09	814.85	834.84	855.08	875.56	896.28	917.25
10	785.40	805.16	825.16	845.41	865.90	886.64	907.63	928.86
10 $\frac{1}{8}$	795.22	815.22	835.48	855.98	876.73	897.73	918.97	940.47
10 $\frac{1}{4}$	805.04	825.29	845.79	866.54	887.55	908.81	930.32	952.08
10 $\frac{3}{8}$	814.85	835.35	856.10	877.11	898.37	919.89	941.66	963.69
10 $\frac{1}{2}$	824.67	845.42	866.42	887.68	909.20	930.98	953.01	975.30
10 $\frac{5}{8}$	834.49	855.48	876.73	898.25	920.02	942.06	964.35	986.91
10 $\frac{3}{4}$	844.31	865.54	887.05	908.82	930.85	953.14	975.70	998.52
10 $\frac{7}{8}$	854.12	875.61	897.36	919.38	941.67	964.22	987.05	1010.13
11	863.94	885.67	907.68	929.95	952.49	975.31	998.39	1021.74
11 $\frac{1}{8}$	873.76	895.74	917.99	940.52	963.32	986.39	1009.74	1033.35
11 $\frac{1}{4}$	883.58	905.80	928.31	951.09	974.14	997.47	1021.08	1044.97
11 $\frac{3}{8}$	893.40	915.87	938.62	961.65	984.97	1008.56	1032.43	1056.58
11 $\frac{1}{2}$	903.21	925.93	948.94	972.22	995.79	1019.64	1043.77	1068.19
11 $\frac{5}{8}$	913.03	936.00	959.25	982.79	1006.61	1030.72	1055.12	1079.80
11 $\frac{3}{4}$	922.85	946.06	969.56	993.36	1017.44	1041.81	1066.46	1091.41
11 $\frac{7}{8}$	932.66	956.12	979.88	1003.92	1028.26	1052.89	1077.81	1103.02
12	942.48	966.19	990.19	1014.49	1039.08	1063.97	1089.15	1114.62

Depth	DIAMETER							
	11	11 $\frac{1}{8}$	11 $\frac{1}{4}$	11 $\frac{3}{8}$	11 $\frac{1}{2}$	11 $\frac{5}{8}$	11 $\frac{3}{4}$	11 $\frac{7}{8}$
21 $\frac{1}{2}$	237.58	243.01	248.51	254.06	259.67	265.35	271.09	276.88
25 $\frac{3}{8}$	249.46	255.16	260.93	266.76	272.66	278.62	284.64	290.73
23 $\frac{1}{4}$	261.34	267.32	273.36	279.46	285.64	291.88	298.20	304.57
27 $\frac{1}{8}$	273.22	279.47	285.78	292.17	298.62	305.15	311.75	318.42
3	285.10	291.62	298.21	304.87	311.61	318.42	325.30	332.26
31 $\frac{1}{8}$	296.98	303.77	310.63	317.57	324.59	331.69	338.86	346.11
31 $\frac{1}{4}$	308.86	315.92	323.06	330.28	337.57	344.95	352.41	359.95
33 $\frac{3}{8}$	320.74	328.07	335.48	342.98	350.56	358.22	365.97	373.79
31 $\frac{1}{2}$	332.62	340.22	347.91	355.68	363.54	371.49	379.52	387.64
35 $\frac{3}{8}$	344.50	352.37	360.33	368.38	376.53	384.76	393.08	401.48
33 $\frac{1}{4}$	356.38	364.52	372.76	381.09	389.51	398.02	406.63	415.33
37 $\frac{1}{8}$	368.25	376.67	385.18	393.79	402.49	411.29	420.18	429.17
4	380.13	388.82	397.61	406.49	415.48	424.56	433.74	443.01
41 $\frac{1}{8}$	392.01	400.97	410.03	419.20	428.46	437.83	447.29	456.86
41 $\frac{1}{4}$	403.89	413.12	422.46	431.90	441.44	451.09	460.85	470.70
43 $\frac{3}{8}$	415.77	425.27	434.88	444.60	454.43	464.36	474.40	484.55
41 $\frac{1}{2}$	427.65	437.42	447.31	457.31	467.41	477.63	487.96	498.39
45 $\frac{3}{8}$	439.53	449.58	459.74	470.01	480.39	490.89	501.51	512.24
43 $\frac{1}{4}$	451.41	461.73	472.16	482.71	493.38	504.16	515.07	526.08
47 $\frac{1}{8}$	463.29	473.88	484.59	495.41	506.36	517.44	528.62	539.92
5	475.17	486.03	497.01	508.12	519.35	530.70	542.17	553.77
51 $\frac{1}{8}$	487.05	498.18	509.44	520.82	532.33	543.96	555.73	567.61
51 $\frac{1}{4}$	498.93	510.33	521.86	533.52	545.31	557.23	569.28	581.46
53 $\frac{3}{8}$	510.80	522.48	534.29	546.23	558.30	570.50	582.84	595.30
51 $\frac{1}{2}$	522.68	534.63	546.71	558.93	571.28	583.77	596.39	609.15
55 $\frac{3}{8}$	534.56	546.78	569.14	571.63	584.26	597.03	609.95	622.99
53 $\frac{1}{4}$	546.44	558.93	571.56	584.33	597.25	610.30	623.50	636.83
57 $\frac{1}{8}$	558.32	571.08	583.99	597.04	610.23	623.57	637.05	650.68
6	570.20	583.23	596.41	609.74	623.21	636.84	650.61	664.52
61 $\frac{1}{8}$	582.08	595.38	608.84	622.44	636.20	650.10	664.16	678.37
61 $\frac{1}{4}$	593.96	607.53	621.26	635.15	649.18	663.37	677.72	692.21
63 $\frac{3}{8}$	605.84	619.69	633.69	647.85	662.17	676.64	691.27	706.05
61 $\frac{1}{2}$	617.72	631.84	646.11	660.55	675.15	689.91	704.83	719.90
65 $\frac{3}{8}$	629.60	643.99	658.54	673.25	688.13	703.17	718.38	733.74
63 $\frac{1}{4}$	641.48	656.14	670.97	686.96	701.12	716.44	731.93	747.59
67 $\frac{1}{8}$	653.35	668.29	683.39	698.66	714.10	729.71	745.49	761.43
7	655.23	680.44	695.82	711.36	727.08	742.98	759.04	775.28
71 $\frac{1}{8}$	677.11	692.59	708.24	724.07	740.07	756.24	772.60	789.12
71 $\frac{1}{4}$	688.99	704.74	720.67	736.77	753.05	769.51	786.15	802.96

Depth	DIAMETER							
	11	11 $\frac{1}{8}$	11 $\frac{1}{4}$	11 $\frac{3}{8}$	11 $\frac{1}{2}$	11 $\frac{5}{8}$	11 $\frac{3}{4}$	11 $\frac{7}{8}$
7 $\frac{3}{8}$	700.87	716.89	733.09	749.47	766.03	782.78	809.71	816.81
7 $\frac{1}{2}$	712.75	729.04	745.52	762.18	779.02	796.05	814.26	830.65
7 $\frac{5}{8}$	724.63	741.18	757.94	774.88	792.00	809.31	826.82	844.50
7 $\frac{3}{4}$	736.51	753.34	770.37	787.58	804.99	822.58	840.37	858.34
7 $\frac{7}{8}$	748.49	765.49	782.79	800.28	817.98	835.85	853.92	872.19
8	760.27	777.64	795.22	812.99	830.95	849.12	867.48	886.03
8 $\frac{1}{8}$	772.15	789.79	807.64	825.69	843.94	862.38	881.03	899.87
8 $\frac{1}{4}$	784.03	801.95	820.07	838.39	856.92	875.65	894.50	913.72
8 $\frac{3}{8}$	795.90	814.10	832.49	851.10	869.90	888.92	908.14	927.56
5 $\frac{1}{2}$	807.88	826.25	844.92	863.80	882.89	902.19	921.70	941.41
8 $\frac{5}{8}$	819.66	838.40	857.34	876.50	895.87	915.45	935.25	955.25
8 $\frac{3}{4}$	831.54	850.55	869.77	889.20	908.85	928.72	948.80	969.09
8 $\frac{7}{8}$	843.42	862.70	882.19	901.91	921.84	941.99	962.36	982.94
9	855.30	874.85	894.62	914.61	934.82	955.25	975.91	996.78
9 $\frac{1}{8}$	867.18	887.00	907.05	927.31	947.81	968.52	989.47	1010.63
6 $\frac{1}{4}$	879.06	899.15	919.47	940.02	960.79	981.79	1003.02	1024.47
9 $\frac{3}{8}$	890.94	911.30	931.90	952.72	973.77	995.06	1016.58	1038.32
9 $\frac{1}{2}$	902.82	923.45	944.32	965.42	986.76	1008.32	1030.13	1052.16
9 $\frac{5}{8}$	914.70	935.60	956.75	978.13	999.74	1021.59	1043.68	1066.00
9 $\frac{3}{4}$	926.58	947.75	969.17	990.83	1012.72	1034.86	1057.24	1079.85
9 $\frac{7}{8}$	938.46	959.90	981.60	1003.43	1025.71	1048.13	1070.79	1093.69
10	950.33	972.06	994.02	1016.23	1038.69	1061.39	1084.35	1107.54
10 $\frac{1}{8}$	962.21	984.21	1006.45	1028.94	1051.97	1074.66	1097.90	1121.38
10 $\frac{1}{4}$	974.09	996.36	1018.87	1041.64	1064.66	1087.93	1111.46	1135.23
10 $\frac{3}{8}$	986.97	1008.51	1031.30	1054.34	1077.64	1101.20	1125.01	1149.07
10 $\frac{1}{2}$	997.85	1020.66	1043.72	1067.05	1090.63	1114.46	1138.57	1162.91
10 $\frac{5}{8}$	1009.73	1032.81	1056.15	1079.75	1103.61	1127.73	1152.12	1176.76
10 $\frac{3}{4}$	1021.61	1044.96	1068.57	1092.45	1116.59	1141.00	1165.67	1190.60
10 $\frac{7}{8}$	1033.49	1057.11	1081.00	1105.15	1129.68	1154.27	1179.23	1204.45
11	1045.37	1069.26	1093.42	1117.86	1142.56	1167.53	1192.78	1218.29
11 $\frac{1}{8}$	1057.25	1081.41	1105.85	1130.56	1155.54	1180.80	1206.34	1232.13
11 $\frac{1}{4}$	1069.13	1093.56	1118.27	1143.26	1168.53	1194.07	1219.89	1245.98
11 $\frac{3}{8}$	1081.01	1105.71	1130.70	1155.97	1181.51	1207.34	1233.45	1259.82
11 $\frac{1}{2}$	1092.88	1117.86	1143.13	1168.67	1194.49	1220.60	1247.00	1273.67
11 $\frac{5}{8}$	1104.76	1130.01	1155.55	1181.37	1207.48	1233.87	1260.55	1287.51
11 $\frac{3}{4}$	1116.64	1142.17	1167.98	1194.07	1220.46	1247.14	1274.11	1301.36
11 $\frac{7}{8}$	1128.52	1154.32	1180.40	1206.78	1233.45	1260.51	1287.66	1314.20
12	1140.40	1166.47	1192.83	1219.48	1246.43	1273.67	1301.22	1329.04

Depth	DIAMETER							
	12	12 $\frac{1}{8}$	12 $\frac{1}{4}$	12 $\frac{3}{8}$	12 $\frac{1}{2}$	12 $\frac{5}{8}$	12 $\frac{3}{4}$	12 $\frac{7}{8}$
2 $\frac{1}{2}$	282.74	288.66	294.65	300.69	306.80	312.96	319.19	325.48
2 $\frac{5}{8}$	296.88	303.10	309.38	315.73	322.14	328.61	335.15	341.75
2 $\frac{3}{4}$	311.02	317.53	324.11	330.76	337.48	344.26	351.11	358.03
2 $\frac{7}{8}$	325.15	331.96	338.84	345.80	352.82	359.91	367.07	364.30
3	339.29	346.40	353.58	360.83	368.16	375.56	383.03	380.58
3 $\frac{1}{8}$	353.43	360.83	368.31	375.86	383.50	391.20	398.99	406.85
3 $\frac{1}{4}$	367.57	375.26	383.04	390.90	398.84	406.85	414.95	423.13
3 $\frac{3}{8}$	381.70	389.70	397.77	405.93	414.18	422.50	430.91	439.40
3 $\frac{1}{2}$	395.84	404.13	412.51	420.97	429.52	438.15	446.87	455.67
3 $\frac{5}{8}$	409.98	418.56	427.24	436.00	444.86	453.80	462.83	471.95
3 $\frac{3}{4}$	424.11	433.00	441.97	451.04	460.20	469.45	478.79	488.22
3 $\frac{7}{8}$	438.25	447.43	456.70	466.07	475.54	485.09	494.75	504.50
4	452.39	461.86	471.44	481.11	490.88	500.74	510.71	520.77
4 $\frac{1}{8}$	466.53	476.30	486.17	496.14	506.21	516.39	526.67	537.04
4 $\frac{1}{4}$	480.66	490.73	500.90	511.18	521.55	532.04	542.63	553.32
4 $\frac{3}{8}$	494.80	505.16	515.63	526.21	536.89	547.69	558.59	569.59
4 $\frac{1}{2}$	508.94	519.60	530.37	541.24	552.23	563.33	574.54	585.87
4 $\frac{5}{8}$	523.08	534.03	545.10	556.28	567.57	578.98	590.50	602.14
4 $\frac{3}{4}$	537.21	548.46	559.83	571.31	582.91	594.63	606.46	618.41
4 $\frac{7}{8}$	551.35	562.90	574.56	586.35	598.25	610.28	622.42	634.69
5	565.49	577.33	589.30	601.38	613.59	625.93	638.38	650.96
5 $\frac{1}{8}$	579.62	591.76	604.03	616.42	628.93	641.58	654.34	667.24
5 $\frac{1}{4}$	593.76	606.20	618.76	631.45	644.27	657.22	670.30	683.51
5 $\frac{3}{8}$	607.90	620.63	633.49	646.49	659.61	672.87	686.26	699.78
5 $\frac{1}{2}$	622.04	635.06	648.23	661.52	674.95	688.52	702.22	716.06
5 $\frac{5}{8}$	636.17	649.50	662.96	676.56	690.29	704.17	718.18	732.33
5 $\frac{3}{4}$	650.31	663.93	677.69	691.59	705.63	719.82	734.14	748.61
5 $\frac{7}{8}$	664.45	678.36	692.42	706.63	720.97	735.46	750.10	764.88
6	678.58	692.79	707.15	721.66	736.31	751.11	766.06	781.15
6 $\frac{1}{8}$	692.72	707.23	721.89	736.69	751.65	766.76	782.02	797.43
6 $\frac{1}{4}$	706.86	721.66	736.62	751.73	766.99	782.41	797.98	813.70
6 $\frac{3}{8}$	721.00	736.09	751.35	766.76	782.33	798.06	813.94	829.98
6 $\frac{1}{2}$	735.13	750.53	766.08	781.80	797.67	813.76	829.90	846.25
6 $\frac{5}{8}$	749.27	764.96	780.82	796.83	813.01	829.35	845.86	862.52
6 $\frac{3}{4}$	763.41	779.39	795.55	811.87	828.35	845.00	861.82	878.80
6 $\frac{7}{8}$	777.54	793.83	810.28	826.90	843.69	860.65	877.78	895.07
7	791.68	808.26	825.01	841.94	859.03	876.30	893.74	911.35
7 $\frac{1}{8}$	805.82	822.69	839.75	856.97	874.37	891.95	909.70	927.62
7 $\frac{1}{4}$	819.96	837.13	854.48	872.01	889.71	907.59	925.66	943.89

Depth	DIAMETER							
	12	12 $\frac{1}{8}$	12 $\frac{1}{4}$	12 $\frac{3}{8}$	12 $\frac{1}{2}$	12 $\frac{5}{8}$	12 $\frac{3}{4}$	12 $\frac{7}{8}$
7 $\frac{3}{8}$	834.09	851.56	869.21	887.04	905.05	923.24	941.61	960.17
8 $\frac{1}{2}$	848.23	865.99	883.94	902.08	920.39	938.89	957.57	976.44
7 $\frac{5}{8}$	862.37	880.43	898.68	917.11	935.73	954.54	973.53	992.72
7 $\frac{3}{4}$	876.50	894.86	913.41	932.14	951.07	970.19	989.49	1008.99
7 $\frac{7}{8}$	890.64	909.29	928.14	947.18	966.41	985.84	1005.45	1025.26
8	904.78	923.73	942.87	962.21	981.75	1001.48	1021.41	1041.54
8 $\frac{1}{8}$	918.92	938.16	957.61	977.25	997.09	1017.13	1037.37	1057.81
8 $\frac{1}{4}$	933.05	952.59	972.34	992.28	1012.43	1032.78	1053.33	1074.09
8 $\frac{3}{8}$	947.19	967.03	987.07	1007.32	1027.77	1048.43	1069.29	1090.36
8 $\frac{1}{2}$	961.33	981.46	1001.80	1022.35	1043.11	1064.08	1085.25	1106.63
8 $\frac{5}{8}$	975.46	995.89	1016.53	1037.38	1058.45	1079.72	1101.21	1122.91
8 $\frac{3}{4}$	989.60	1010.33	1031.27	1052.32	1073.79	1095.37	1117.17	1139.18
8 $\frac{7}{8}$	1003.74	1024.76	1046.00	1067.46	1089.13	1111.02	1133.13	1155.46
9	1017.88	1039.19	1060.73	1082.49	1104.47	1126.67	1149.09	1171.73
9 $\frac{1}{8}$	1032.01	1053.63	1075.46	1097.52	1119.81	1142.32	1165.05	1188.00
9 $\frac{1}{4}$	1046.15	1068.06	1090.20	1112.56	1135.15	1157.97	1181.01	1204.28
9 $\frac{3}{8}$	1060.29	1082.49	1104.93	1127.59	1150.49	1173.61	1196.97	1220.55
9 $\frac{1}{2}$	1074.42	1096.93	1119.66	1142.63	1165.83	1189.26	1212.93	1236.82
9 $\frac{5}{8}$	1188.56	1111.36	1134.39	1157.66	1181.17	1204.91	1228.89	1253.10
9 $\frac{3}{4}$	1102.70	1125.79	1149.13	1172.70	1196.51	1220.56	1244.85	1269.37
9 $\frac{7}{8}$	1116.84	1140.22	1163.86	1187.73	1211.85	1236.21	1260.81	1285.65
10	1130.97	1154.65	1178.59	1202.77	1227.19	1251.85	1276.77	1301.92
10 $\frac{1}{8}$	1145.11	1169.09	1193.32	1217.80	1242.53	1267.50	1292.73	1318.20
10 $\frac{1}{4}$	1159.25	1183.52	1208.06	1232.84	1257.87	1283.15	1308.69	1334.47
10 $\frac{3}{8}$	1173.38	1197.90	1222.79	1247.87	1273.21	1298.80	1324.64	1350.75
10 $\frac{1}{2}$	1187.52	1212.39	1237.52	1262.90	1288.55	1314.45	1340.60	1367.02
10 $\frac{5}{8}$	1201.66	1226.82	1252.25	1277.94	1303.69	1330.09	1356.56	1383.29
10 $\frac{3}{4}$	1215.80	1241.26	1266.99	1292.97	1319.23	1345.75	1372.52	1399.57
10 $\frac{7}{8}$	1229.63	1255.99	1281.72	1308.01	1334.57	1361.39	1388.48	1415.84
11	1244.07	1270.12	1296.45	1323.04	1349.91	1377.04	1404.44	1432.12
11 $\frac{1}{8}$	1258.21	1284.56	1311.18	1338.08	1365.25	1392.69	1420.40	1448.39
11 $\frac{1}{4}$	1272.34	1298.99	1325.91	1353.11	1380.59	1408.33	1436.36	1464.66
11 $\frac{3}{8}$	1286.48	1313.42	1340.65	1368.15	1395.93	1423.97	1452.32	1480.94
11 $\frac{1}{2}$	1300.62	1327.86	1355.38	1383.18	1411.26	1439.63	1468.28	1497.21
11 $\frac{5}{8}$	1314.76	1342.29	1370.11	1398.22	1426.61	1455.28	1484.24	1513.49
11 $\frac{3}{4}$	1328.89	1356.72	1384.84	1413.25	1441.95	1470.93	1500.20	1529.76
11 $\frac{7}{8}$	1343.03	1371.16	1399.58	1428.29	1457.28	1486.58	1516.16	1546.03
12	1357.17	1385.59	1414.31	1443.32	1472.63	1502.22	1532.12	1562.21

Depth	DIAMETER							
	13	13 $\frac{1}{8}$	13 $\frac{1}{4}$	13 $\frac{3}{8}$	13 $\frac{1}{2}$	13 $\frac{5}{8}$	13 $\frac{3}{4}$	13 $\frac{7}{8}$
2 $\frac{1}{2}$	331.84	338.26	344.68	351.26	357.84	364.54	371.24	378.04
2 $\frac{5}{8}$	348.44	355.18	361.92	368.84	375.76	382.78	389.80	396.94
2 $\frac{3}{4}$	365.00	372.08	379.16	386.41	393.64	401.00	408.36	415.84
2 $\frac{7}{8}$	381.60	388.99	396.40	403.98	411.52	419.22	426.92	434.73
3	398.20	405.90	413.64	421.55	429.40	437.44	445.48	453.62
3 $\frac{1}{8}$	414.80	422.81	428.44	439.12	447.32	455.66	464.04	472.51
3 $\frac{1}{4}$	431.40	439.72	448.08	456.69	465.20	473.88	482.60	491.40
3 $\frac{3}{8}$	447.96	456.63	465.28	474.26	483.08	492.10	501.16	510.29
3 $\frac{1}{2}$	464.56	473.54	482.56	491.83	501.00	510.32	519.72	529.18
3 $\frac{5}{8}$	481.16	490.45	499.80	509.40	518.88	528.54	538.28	548.07
3 $\frac{3}{4}$	497.74	507.36	517.04	526.97	536.76	546.76	556.84	567.01
3 $\frac{7}{8}$	514.32	524.27	534.24	544.54	554.56	564.98	575.40	585.91
4	530.92	541.18	551.52	562.11	572.56	583.20	593.96	604.81
4 $\frac{1}{8}$	547.52	558.09	568.72	579.68	590.44	601.43	612.52	623.70
4 $\frac{1}{4}$	564.12	575.00	585.96	597.25	608.36	619.66	631.08	642.60
4 $\frac{3}{8}$	580.72	591.91	603.20	614.82	626.24	637.89	649.64	661.50
4 $\frac{1}{2}$	597.28	608.82	620.44	632.39	644.12	656.12	668.20	680.40
4 $\frac{5}{8}$	613.88	625.73	637.68	649.96	662.00	674.35	686.76	699.29
4 $\frac{3}{4}$	630.48	642.64	654.88	667.43	679.92	692.58	705.32	718.18
4 $\frac{7}{8}$	647.08	659.55	672.12	685.00	697.80	710.81	723.88	737.08
5	663.68	676.46	689.36	702.57	715.68	729.04	742.44	755.98
5 $\frac{1}{8}$	680.24	693.37	706.60	720.14	733.60	747.27	761.00	774.88
5 $\frac{1}{4}$	696.84	710.28	723.84	737.71	751.48	765.50	779.56	793.78
5 $\frac{3}{8}$	713.44	727.19	741.08	755.28	769.36	783.73	798.12	812.69
5 $\frac{1}{2}$	730.04	744.10	758.32	772.85	787.28	801.96	816.68	831.60
5 $\frac{5}{8}$	746.64	761.01	775.56	790.42	805.16	820.18	835.24	850.51
5 $\frac{3}{4}$	763.20	777.92	792.76	807.99	823.04	838.40	853.80	869.42
5 $\frac{7}{8}$	779.80	794.83	810.00	825.52	840.96	856.62	872.36	888.34
6	796.40	811.74	827.24	843.19	858.84	874.84	890.92	907.27
6 $\frac{1}{8}$	813.00	828.65	844.48	860.66	876.72	893.06	909.48	926.19
6 $\frac{1}{4}$	829.56	845.56	861.72	878.23	894.60	911.28	928.04	945.10
6 $\frac{3}{8}$	846.16	862.47	878.96	895.79	912.52	929.50	946.60	963.99
6 $\frac{1}{2}$	862.76	879.38	896.20	913.35	930.40	947.73	965.16	982.88
6 $\frac{5}{8}$	879.36	896.29	913.44	930.91	948.28	965.96	983.72	1001.78
6 $\frac{3}{4}$	895.96	913.20	930.64	958.57	966.20	984.19	1002.28	1020.69
6 $\frac{7}{8}$	912.52	930.11	947.88	976.13	984.08	1002.42	1020.84	1039.61
7	929.12	947.02	965.12	993.69	1001.96	1020.65	1039.40	1058.50
7 $\frac{1}{8}$	945.72	963.93	982.36	1001.25	1019.88	1038.88	1057.96	1077.39
7 $\frac{1}{4}$	962.32	980.94	999.60	1018.71	1037.76	1057.11	1076.52	1096.30

Depth	DIAMETER							
	13	13 $\frac{1}{8}$	13 $\frac{1}{4}$	13 $\frac{3}{8}$	13 $\frac{1}{2}$	13 $\frac{5}{8}$	13 $\frac{3}{4}$	13 $\frac{7}{8}$
7 $\frac{3}{8}$	978.92	997.88	1016.84	1036.24	1055.64	1075.38	1095.12	1115.20
7 $\frac{1}{2}$	995.48	1014.78	1034.08	1053.82	1073.56	1093.62	1113.68	1134.10
7 $\frac{5}{8}$	1012.08	1031.69	1051.28	1071.38	1091.44	1111.84	1132.24	1153.00
7 $\frac{3}{4}$	1028.68	1048.60	1068.52	1088.94	1109.32	1130.06	1150.80	1171.90
7 $\frac{7}{8}$	1045.28	1065.51	1085.76	1106.50	1127.40	1148.28	1169.26	1190.80
8	1061.88	1082.42	1103.00	1124.06	1145.12	1166.50	1187.92	1209.70
8 $\frac{1}{8}$	1078.44	1099.33	1120.24	1141.62	1163.00	1184.72	1206.48	1228.61
8 $\frac{1}{4}$	1095.04	1116.24	1137.48	1159.18	1180.92	1202.94	1225.04	1247.51
8 $\frac{3}{8}$	1111.64	1133.15	1154.72	1176.74	1198.80	1221.18	1243.60	1266.41
8 $\frac{1}{2}$	1128.24	1150.06	1171.92	1194.30	1216.68	1239.41	1262.16	1285.32
8 $\frac{5}{8}$	1144.80	1166.97	1189.16	1211.86	1234.54	1257.64	1280.72	1304.21
8 $\frac{3}{4}$	1161.40	1183.88	1206.40	1229.42	1252.48	1275.87	1299.28	1323.11
8 $\frac{7}{8}$	1178.00	1200.79	1223.64	1246.98	1270.36	1294.10	1317.84	1342.01
9	1194.60	1217.70	1240.88	1264.54	1288.24	1312.33	1336.40	1360.92
9 $\frac{1}{8}$	1211.20	1234.61	1258.12	1282.10	1306.16	1330.56	1354.96	1379.82
9 $\frac{1}{4}$	1227.76	1251.52	1275.36	1299.66	1324.04	1348.79	1373.52	1398.72
9 $\frac{3}{8}$	1244.36	1268.43	1292.56	1317.22	1341.92	1367.02	1392.08	1417.62
9 $\frac{1}{2}$	1260.96	1285.34	1309.80	1334.78	1359.84	1385.24	1410.64	1436.53
9 $\frac{5}{8}$	1277.56	1302.25	1327.04	1352.34	1377.72	1403.46	1429.20	1455.43
9 $\frac{3}{4}$	1294.16	1319.16	1344.28	1369.92	1395.60	1421.68	1447.76	1474.33
9 $\frac{7}{8}$	1310.72	1336.07	1361.32	1387.50	1413.48	1439.80	1466.32	1493.23
10	1327.32	1352.97	1378.76	1405.08	1431.40	1458.02	1484.88	1512.14
10 $\frac{1}{8}$	1343.92	1369.87	1396.00	1422.66	1449.28	1476.24	1503.44	1531.04
10 $\frac{1}{4}$	1360.52	1386.77	1412.90	1440.22	1467.16	1494.47	1522.00	1549.94
10 $\frac{3}{8}$	1377.12	1403.67	1430.44	1457.78	1485.08	1512.70	1540.56	1568.85
10 $\frac{1}{2}$	1393.68	1420.58	1447.68	1475.34	1502.96	1530.93	1559.12	1587.75
10 $\frac{5}{8}$	1410.28	1437.49	1464.92	1492.90	1520.84	1549.26	1577.68	1606.64
10 $\frac{3}{4}$	1426.88	1454.60	1482.16	1510.46	1538.76	1567.49	1596.24	1625.54
10 $\frac{7}{8}$	1443.48	1471.51	1499.40	1528.02	1556.64	1585.72	1614.80	1644.44
11	1460.04	1488.42	1516.64	1545.58	1574.52	1603.95	1633.36	1663.35
11 $\frac{1}{8}$	1476.64	1505.33	1533.84	1563.14	1592.44	1622.17	1651.92	1682.25
11 $\frac{1}{4}$	1493.24	1522.23	1551.08	1580.70	1610.32	1640.39	1670.48	1701.14
11 $\frac{3}{8}$	1509.84	1539.13	1568.32	1598.26	1628.20	1658.61	1689.04	1719.05
11 $\frac{1}{2}$	1526.44	1556.03	1585.56	1615.82	1646.08	1676.84	1707.60	1738.95
11 $\frac{5}{8}$	1543.00	1572.93	1602.80	1633.38	1664.00	1695.07	1726.16	1757.86
11 $\frac{3}{4}$	1559.60	1589.83	1620.04	1650.95	1681.88	1713.29	1744.72	1776.76
11 $\frac{7}{8}$	1576.20	1606.73	1637.28	1668.52	1699.76	1731.52	1763.28	1795.66
12	1592.80	1623.66	1654.52	1686.09	1717.68	1749.75	1781.84	1814.56

Depth	DIAMETER							
	14	14 $\frac{1}{8}$	14 $\frac{1}{4}$	14 $\frac{3}{8}$	14 $\frac{1}{2}$	14 $\frac{5}{8}$	14 $\frac{3}{4}$	14 $\frac{7}{8}$
2 $\frac{1}{2}$	384.84	391.78	398.72	405.78	412.84	420.02	427.20	434.50
2 $\frac{5}{8}$	404.08	411.36	418.64	426.06	433.48	441.02	448.56	456.22
2 $\frac{3}{4}$	421.32	429.96	438.60	446.36	454.12	462.03	469.92	477.94
2 $\frac{7}{8}$	442.56	450.54	458.52	466.64	474.76	483.01	491.28	499.66
3	461.80	470.12	478.44	486.92	495.40	504.02	512.64	521.39
3 $\frac{1}{8}$	481.04	489.70	498.40	507.10	516.04	525.02	534.00	543.12
3 $\frac{1}{4}$	500.32	509.28	518.32	527.38	536.68	546.01	555.32	564.85
3 $\frac{3}{8}$	519.56	528.86	538.28	547.66	557.32	567.03	576.68	586.57
3 $\frac{1}{2}$	538.80	548.44	558.20	567.98	577.96	588.02	598.04	608.29
3 $\frac{5}{8}$	558.04	568.02	578.12	588.28	598.60	609.01	619.40	630.02
3 $\frac{3}{4}$	577.28	587.60	598.08	608.58	619.24	630.03	640.76	651.74
3 $\frac{7}{8}$	596.52	607.20	618.00	628.86	639.88	651.03	662.12	673.46
4	615.76	626.80	637.96	649.26	660.52	672.01	683.48	695.19
4 $\frac{1}{8}$	635.00	646.40	657.88	669.54	681.16	693.00	704.84	716.91
4 $\frac{1}{4}$	654.34	665.98	677.80	689.82	701.80	714.01	726.20	738.63
4 $\frac{3}{8}$	673.48	685.56	697.76	710.10	722.44	735.02	747.56	760.35
4 $\frac{1}{2}$	692.72	705.15	717.68	730.38	743.08	756.00	768.92	782.07
4 $\frac{5}{8}$	711.96	724.74	737.60	750.66	763.72	777.01	790.28	803.79
4 $\frac{3}{4}$	731.20	744.33	757.56	770.94	784.36	798.03	811.64	825.52
4 $\frac{7}{8}$	750.44	763.92	777.48	791.22	805.00	819.02	832.00	847.25
5	769.68	783.51	797.44	811.50	825.64	840.02	854.36	868.97
5 $\frac{1}{8}$	788.92	803.10	817.36	831.79	846.28	861.01	875.72	890.69
5 $\frac{1}{4}$	808.16	822.69	837.28	852.08	866.92	882.01	897.18	912.41
5 $\frac{3}{8}$	827.40	842.28	857.24	872.37	887.56	903.02	918.44	934.13
5 $\frac{1}{2}$	846.68	861.87	877.16	892.66	908.20	924.00	939.60	955.85
5 $\frac{5}{8}$	865.92	881.46	897.12	912.95	928.84	945.01	961.16	977.57
5 $\frac{3}{4}$	885.16	901.05	917.04	933.24	949.48	966.00	982.52	999.29
5 $\frac{7}{8}$	904.40	920.64	936.96	953.53	970.16	987.02	1003.88	1021.01
6	923.64	940.23	956.92	973.82	990.80	1008.02	1025.24	1042.75
6 $\frac{1}{8}$	942.88	959.82	976.84	994.12	1011.44	1029.01	1046.60	1064.48
6 $\frac{1}{4}$	962.12	979.41	996.80	1014.42	1032.08	1050.01	1067.96	1086.20
6 $\frac{3}{8}$	981.36	999.00	1016.72	1034.72	1052.72	1071.02	1089.32	1107.93
6 $\frac{1}{2}$	1000.60	1018.59	1036.64	1055.02	1073.36	1092.02	1110.68	1129.65
6 $\frac{5}{8}$	1019.84	1038.18	1056.60	1075.32	1094.00	1113.01	1132.04	1151.37
6 $\frac{3}{4}$	1038.08	1057.77	1076.52	1095.61	1114.64	1134.01	1153.40	1173.10
6 $\frac{7}{8}$	1059.32	1077.36	1096.48	1115.90	1135.28	1155.00	1174.76	1194.82
7	1077.56	1096.95	1116.40	1136.19	1155.92	1176.02	1196.12	1216.54
7 $\frac{1}{8}$	1096.80	1116.54	1136.32	1156.40	1176.56	1197.02	1217.48	1238.27
7 $\frac{1}{4}$	1116.04	1136.13	1156.28	1176.69	1197.20	1218.02	1238.84	1260.00

Depth	DIAMETER							
	14	14 $\frac{1}{8}$	14 $\frac{1}{4}$	14 $\frac{3}{8}$	14 $\frac{1}{2}$	14 $\frac{5}{8}$	14 $\frac{3}{4}$	14 $\frac{7}{8}$
7 $\frac{3}{8}$	1135.28	1155.74	1176.20	1197.02	1217.84	1239.02	1260.20	1281.72
7 $\frac{1}{2}$	1154.52	1175.32	1196.12	1217.30	1238.48	1260.02	1281.56	1303.45
7 $\frac{5}{8}$	1173.80	1194.90	1216.08	1237.58	1259.12	1281.01	1302.92	1325.17
7 $\frac{3}{4}$	1192.84	1214.48	1236.00	1257.86	1279.76	1302.01	1324.28	1346.90
7 $\frac{7}{8}$	1212.28	1234.06	1255.96	1278.14	1300.40	1323.02	1345.64	1368.62
8	1231.52	1253.65	1275.88	1298.42	1321.04	1344.01	1367.00	1390.35
8 $\frac{1}{8}$	1251.76	1273.24	1295.80	1318.72	1341.68	1365.00	1388.36	1412.08
8 $\frac{1}{4}$	1270.00	1292.83	1315.76	1339.02	1362.32	1386.02	1409.72	1433.81
8 $\frac{3}{8}$	1289.24	1312.42	1335.68	1359.31	1382.96	1407.01	1431.08	1455.53
8 $\frac{1}{2}$	1308.48	1332.02	1355.64	1379.60	1403.60	1428.00	1452.44	1477.25
8 $\frac{5}{8}$	1327.72	1351.62	1375.56	1399.89	1424.24	1449.02	1474.80	1498.98
8 $\frac{3}{4}$	1346.96	1371.22	1395.48	1420.17	1445.08	1470.01	1495.16	1520.70
8 $\frac{7}{8}$	1366.20	1390.82	1415.44	1440.45	1465.52	1491.02	1516.52	1542.43
9	1385.44	1410.42	1435.36	1460.73	1486.16	1512.02	1537.88	1564.15
9 $\frac{1}{8}$	1404.68	1430.00	1455.32	1481.03	1506.80	1533.01	1559.24	1585.88
9 $\frac{1}{4}$	1423.92	1449.58	1475.24	1501.33	1527.44	1554.02	1580.60	1607.61
9 $\frac{3}{8}$	1443.16	1469.16	1495.16	1521.63	1548.08	1575.02	1601.96	1629.33
9 $\frac{1}{2}$	1462.40	1488.74	1515.12	1541.92	1568.72	1596.01	1623.28	1651.05
9 $\frac{5}{8}$	1481.64	1508.32	1535.04	1562.21	1589.36	1617.00	1644.64	1672.78
9 $\frac{3}{4}$	1500.92	1527.90	1555.00	1582.50	1610.04	1638.02	1666.00	1694.50
9 $\frac{7}{8}$	1520.16	1547.48	1574.92	1602.78	1630.68	1659.02	1687.36	1716.23
10	1539.40	1567.07	1594.84	1623.08	1651.32	1680.01	1708.72	1737.94
10 $\frac{1}{8}$	1558.64	1586.68	1614.80	1643.37	1671.96	1701.02	1730.08	1759.66
10 $\frac{1}{4}$	1577.88	1606.28	1634.72	1663.66	1692.60	1722.02	1751.44	1781.38
10 $\frac{3}{8}$	1597.12	1625.88	1654.64	1683.94	1713.24	1743.02	1772.80	1803.11
10 $\frac{1}{2}$	1616.36	1645.48	1674.60	1704.22	1733.88	1764.01	1794.16	1824.84
10 $\frac{5}{8}$	1635.60	1665.07	1694.52	1724.50	1754.52	1785.02	1815.52	1846.56
10 $\frac{3}{4}$	1654.84	1684.66	1714.48	1744.79	1775.16	1806.01	1836.88	1868.28
10 $\frac{7}{8}$	1674.18	1704.25	1734.40	1765.08	1795.80	1827.02	1858.24	1890.01
11	1693.32	1723.83	1754.32	1785.37	1816.44	1848.02	1879.60	1911.74
11 $\frac{1}{8}$	1712.56	1743.41	1774.38	1805.66	1837.08	1869.01	1900.96	1933.46
11 $\frac{1}{4}$	1731.80	1762.99	1794.20	1825.95	1857.72	1890.02	1922.32	1955.18
11 $\frac{3}{8}$	1751.04	1782.58	1814.16	1846.24	1878.36	1911.01	1943.68	1976.90
11 $\frac{1}{2}$	1770.28	1802.17	1834.08	1866.52	1899.00	1932.02	1965.04	1998.62
11 $\frac{5}{8}$	1789.12	1821.75	1854.00	1886.82	1919.64	1953.02	1986.40	2020.34
11 $\frac{3}{4}$	1808.76	1841.34	1873.96	1907.11	1940.28	1974.01	2007.76	2042.07
11 $\frac{7}{8}$	1828.00	1860.93	1893.88	1927.39	1960.92	1995.02	2029.12	2063.79
12	1847.28	1880.54	1913.84	1947.69	1981.56	2016.02	2050.48	2085.53

## U. S. DRY CAPACITY MEASURES

The different cylindrical measures should contain very nearly the following number of cubic inches, and should conform with the different diameters and depths of this table, taking the Winchester Bushel for the U. S. Standard, which contains 2150.42 cubic inches. Diameter  $18\frac{1}{2}$  inches, depth 8 inches.

These are used in connection with the dry measure gauge or an ordinary rule. To illustrate the use of the table, consider the following example: suppose the sealer is examining a measure that is supposed to be one peck and finds that the diameter is  $9\frac{1}{4}$  inches, then to have the correct capacity its depth should be 8 inches, as given in the table.

ONE-HALF BUSHEL		ONE PECK		ONE-HALF PECK	
Diam. in.	Depth in.	Diam. in.	Depth in.	Diam. in.	Depth in.
$12\frac{1}{2}$	$8\frac{3}{4}$	8	$10\frac{3}{4}$	$6\frac{1}{4}$	$8\frac{3}{4}$
$12\frac{5}{8}$	$8\frac{9}{16}$	$8\frac{1}{4}$	10	$6\frac{1}{2}$	$8\frac{1}{8}$
$12\frac{3}{4}$	$8\frac{7}{16}$	$8\frac{1}{2}$	$9\frac{1}{2}$	$6\frac{3}{4}$	$7\frac{1}{2}$
$12\frac{7}{8}$	$8\frac{1}{4}$	$8\frac{3}{4}$	9	7	7
13	$8\frac{1}{8}$	9	$8\frac{1}{2}$	$7\frac{1}{4}$	$6\frac{1}{2}$
$13\frac{1}{8}$	$7\frac{15}{16}$	$9\frac{1}{4}$	8	$7\frac{1}{2}$	$6\frac{1}{8}$
$13\frac{1}{4}$	$7\frac{13}{16}$	$9\frac{1}{2}$	$7\frac{5}{8}$	$7\frac{3}{4}$	$5\frac{11}{16}$
$13\frac{3}{8}$	$7\frac{5}{8}$	$9\frac{3}{4}$	$7\frac{1}{4}$	8	$5\frac{3}{8}$
$13\frac{1}{2}$	$7\frac{1}{2}$	10	$6\frac{7}{8}$	$8\frac{1}{8}$	$5\frac{3}{16}$
$13\frac{5}{8}$	$7\frac{3}{8}$	$10\frac{1}{8}$	$6\frac{11}{16}$	$8\frac{1}{4}$	5
$13\frac{3}{4}$	$7\frac{1}{4}$	$10\frac{1}{4}$	$6\frac{1}{2}$	$8\frac{3}{8}$	$4\frac{7}{8}$
$13\frac{7}{8}$	$7\frac{1}{8}$	$10\frac{3}{8}$	$6\frac{3}{8}$	$8\frac{1}{2}$	$4\frac{3}{4}$
14	7	$10\frac{1}{2}$	$6\frac{3}{16}$	$8\frac{5}{8}$	$4\frac{3}{8}$
$14\frac{1}{4}$	$6\frac{3}{4}$	$10\frac{5}{8}$	$6\frac{1}{16}$	$8\frac{3}{4}$	$4\frac{1}{2}$
$14\frac{1}{2}$	$6\frac{1}{2}$	$10\frac{3}{4}$	$5\frac{15}{16}$	$8\frac{7}{8}$	$4\frac{5}{16}$
$14\frac{3}{4}$	$6\frac{1}{4}$	$10\frac{7}{8}$	$5\frac{3}{4}$	9	$4\frac{1}{4}$
		11	$5\frac{5}{8}$	$9\frac{1}{8}$	$4\frac{1}{8}$
		$11\frac{1}{8}$	$5\frac{1}{2}$		
		$11\frac{1}{4}$	$5\frac{3}{8}$		
		$11\frac{1}{2}$	$5\frac{1}{8}$		
		$11\frac{3}{4}$	5		

TWO QUARTS		ONE QUART		ONE PINT	
Diam. in.	Depth in.	Diam. in.	Depth in.	Diam. in.	Depth in.
$4\frac{3}{4}$	$7\frac{5}{8}$	$2\frac{3}{4}$	$11\frac{3}{8}$	2	$10\frac{5}{8}$
5	$6\frac{7}{8}$	3	$9\frac{1}{2}$	$2\frac{1}{4}$	$8\frac{1}{2}$
$5\frac{1}{4}$	$6\frac{1}{4}$	$3\frac{1}{4}$	$8\frac{1}{8}$	$2\frac{1}{2}$	$6\frac{7}{8}$
$5\frac{1}{2}$	$5\frac{5}{8}$	$3\frac{1}{2}$	7	$2\frac{3}{4}$	$5\frac{1}{8}$
$5\frac{3}{4}$	$5\frac{1}{8}$	$3\frac{3}{4}$	$6\frac{1}{8}$	3	$4\frac{1}{4}$
6	$4\frac{3}{4}$	4	$5\frac{3}{8}$	$3\frac{1}{4}$	4
$6\frac{1}{8}$	$4\frac{9}{16}$	$4\frac{1}{4}$	$4\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{2}$
$6\frac{1}{4}$	$4\frac{3}{8}$	$4\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{4}$	3
$6\frac{3}{8}$	$4\frac{3}{16}$	$4\frac{3}{4}$	$3\frac{1}{4}$	4	$2\frac{5}{8}$
$6\frac{1}{2}$	$4\frac{1}{16}$	5	$3\frac{7}{16}$	$4\frac{1}{4}$	$2\frac{3}{8}$
$6\frac{5}{8}$	$3\frac{7}{8}$	$5\frac{1}{8}$	$3\frac{1}{4}$		
$6\frac{3}{4}$	$3\frac{1}{4}$	$5\frac{1}{4}$	$3\frac{1}{8}$		
$6\frac{7}{8}$	$3\frac{5}{8}$	$5\frac{3}{8}$	$2\frac{15}{16}$		
7	$3\frac{1}{2}$	$5\frac{1}{2}$	$2\frac{13}{16}$		
		$5\frac{5}{8}$	$2\frac{11}{16}$		
		$5\frac{3}{4}$	$2\frac{9}{16}$		
		$5\frac{7}{8}$	$2\frac{1}{2}$		
		6	$2\frac{3}{8}$		

Liquid Measure			Dry Measure		
1	gallon	contains 231	cu. in. 1	bushel	contains 2150.42 cu. in.
$1\frac{1}{2}$	"	115.5	"	$1\frac{1}{2}$ "	1075.21 "
1	quart	57.75	"	1 peck	537.60 "
1	pint	28.875	"	$1\frac{1}{2}$ "	268.80 "
$1\frac{1}{2}$	"	14.437	"	$1\frac{1}{4}$ "	134.40 "
1	gill	7.218	"	1 quart	67.20 "
1	fluid oz.	1.804	"	1 pint	33.60 "
1	dram	.225	"	$1\frac{1}{2}$ "	16.80 "

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